Trimble 4D Control Rail Monitoring

User guide

TRIMBLE MONITORING
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Content

Introduction

Key Benefits and Applications

Rail Monitoring is becoming increasingly important in today's environment with the fast-growing demand for energy-efficient modes of transport. Understanding the behavior of rail track geometry is essential to ensuring the safety of railway traffic, whether in areas where construction is taking place, regions prone to natural hazards, or where aging infrastructure is awaiting renewal. The purpose of track monitoring is to record railroad track geometry data before, during, and after the completion of construction or to make sure that the track geometry stays stable. The reference geometry data is constantly compared to the newly calculated data in order to determine if the track's geometry has been adversely affected. If the track geometry has been affected, the data can be used to alert the stakeholders to take appropriate action and reestablish design or as-built conditions. Trimble 4D Control offers the possibility to monitor the most important rail track geometry parameters, which helps maintain high rail safety standards.

Figure 1: *Total station monitoring the rail infrastructure*

Rail Monitoring Parameters

As a sensor for rail monitoring purposes, **AMTS (Automated Monitoring Total Station)** and **prisms** or **Tiltmeters** can be used.

In case of AMTS being used, the total station measures the prisms installed/glued on the sleeper or installed/mounted on the rail (see section Rail Monitoring Prisms). These prisms are used as prism pairs on the specific distance along the track, called chainage, to calculate the rail monitoring parameters (see below).

In case tiltmeters are used, they are installed on sleepers at a defined distance between them.

Cant

Cant is the difference in elevation between the top of the two rail heads at a chainage. Cant is calculated as the top of the left rail elevation minus the top of the right rail elevation.

Twist

Twist is the difference in cant between two chainages.

When expressed in ‰ or %, the twist is calculated as the cant value of the chainage ahead minus the cant value of the previous change and then divided by the distance between the two chainages.

When expressed in one of the units of length, the twist is calculated as the cant value of the chainage ahead minus the cant value of the previous change.

Twist as a gradient is expressed as a ratio, e.g., 1 in 100 means a rise of 1 unit over a distance of 100 units.

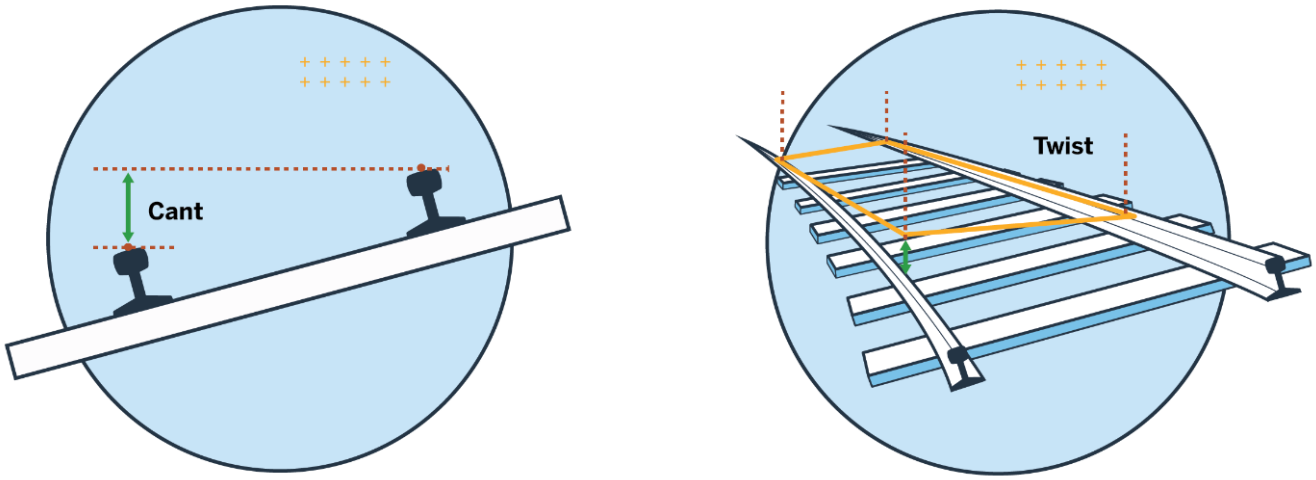

Figure 2: *Illustration of cant and twist*

Horizontal Displacement

Horizontal displacement is the change in the track's position laterally when compared to the reference epoch. Horizontal displacement can be calculated for the track centerline, left rail and right rail.

Vertical Displacement

Vertical displacement is the change in the track's elevation when compared to the reference epoch. Vertical displacement can be calculated for the track centerline, left rail and right rail.

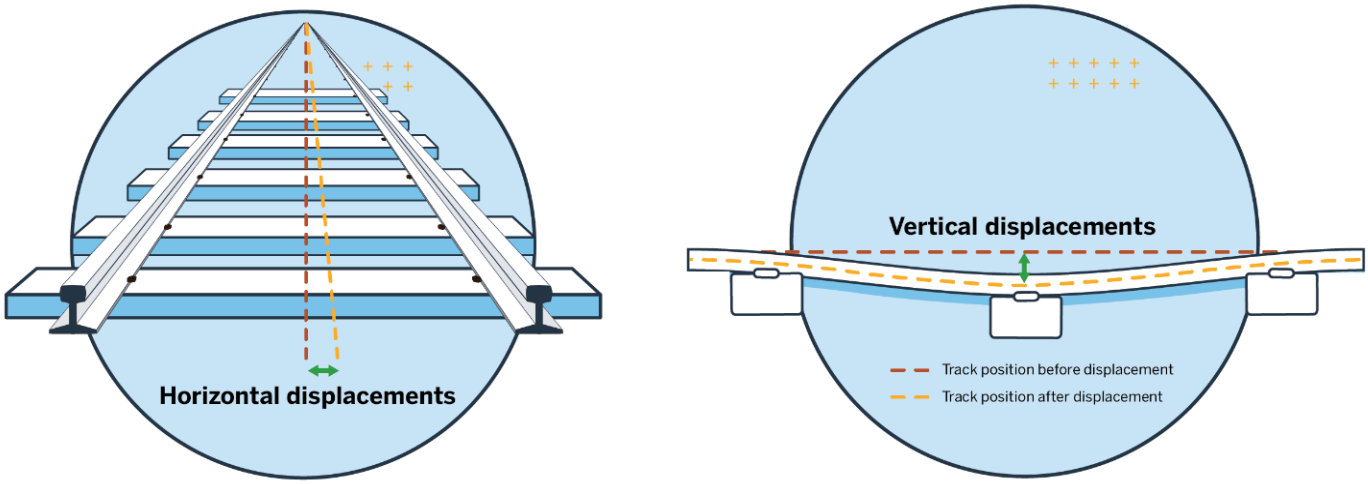

Figure 3: *Illustration of horizontal and vertical displacement of the track's centerline*

Horizontal Versine

In addition to horizontal displacements, **Horizontal Versine** can also be monitored. **Horizontal Versine** is the variation in the track's horizontal position over a certain distance (chord length).

Horizontal Versine Displacement

Horizontal Versine Displacement is the variation in the track's horizontal displacements over a certain distance (chord length). Horizontal versine is calculated as the horizontal displacement at the chainage minus the average horizontal displacement for its two neighboring chainages.

Vertical Versine

Vertical versine is the variation in the track's elevation over a certain distance (chord length). Vertical versine is calculated as the elevation of the track's defined axis at the chainage minus the average elevation of the track's defined axis for its two neighboring chainages.

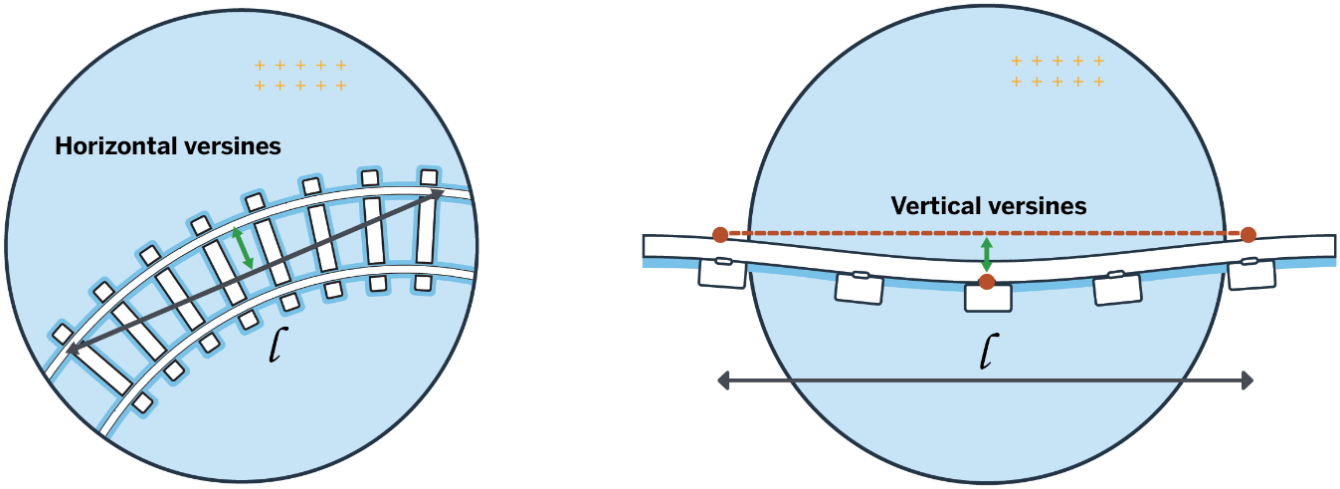

Figure 4: *Illustration of horizontal and vertical versine*

Observation age

Additionally to the rail geometry parameters, it is possible to monitor or display the **Observation age** of the measurements. In the rail industry, it can happen that one or more monitoring prisms were not measured due to various reasons, including passing trains, prisms being blocked or destroyed, etc.

The Trimble 4D Control Rail module offers the possibility to see and monitor how old the measurement is, which is used to calculate the rail parameters. Observation age is calculated as the time between the current calculation date and the date of the latest available measurement of a particular prism. Depending on the project specifications, you can create time thresholds to be alerted when unwanted old measurements are being used for the calculations.

As of version 6.5, in case the Observation Age parameter has reached the Alarm threshold, the parameter calculation will stop to avoid unwanted old measurements being used for the parameter calculation.

Figure 5: *Observation Age parameter thresholds*

As-built survey - Trimble Access Track Gauge Survey app

Introduction and key functionalities

Track Gauge Survey app is the field software integrated into Trimble Access for Windows operating systems used for measuring track parameters. After completing the station setup using coordinated reference points, the coordinates of the track centerline, left and right rail, gauge, and cant can be measured with the track gauge bar.

Project settings

When creating the first job in a new project, the track gauge configuration, the reference gauge, and the cant base must be defined, which are then applied to the entire project. These settings remain unchangeable for all jobs. Subsequent changes are no longer possible. Settings for the prism, target height, measuring lines/tracks, point names, and codes can be freely adjusted.

Measurement principle

The total station measurements of the prisms on the movable or fixed side can take place in a constant sequence, with the fixed side first, the movable side first, or in an alternating measurement sequence. The use of different prisms and target heights on one track gauge bar is possible. After measuring both prisms on the track gauge bar, the measurements are saved in the database.

Automation

The use of total station functions such as tracking and "turn to" brings time savings. The prism on the bar is tracked as it moves to the next position. After measuring the first prism, an estimation of the second prism's position takes place. The measurement is made directly by the user after automatically targeting the second prism. Manual aiming of the prisms is thus no longer necessary.

Data output

The main benefit of using the Trimble Access Track Gauge Survey app is the possibility of exporting the Track file directly from the field. This file is a 3D representation of the entire actual track position in a non-readable binary format. The Track file is being used in the Trimble 4D Control Rail module to calculate offsets from a measured prism to a corresponding position on top of the rail head. It is also used to pass the measurement data internally to other Trimble software programs, such as Trimble GEDO Office, which can subsequently further process it or export files based on the Track file.

The "Track Complete" report exports the measurement data in a structured form based on columns. A simple import, e.g., into Excel for further processing, can then be easily carried out. It is still possible to export a job in different formats, e.g., JobXML.

Initial installation

Downloading the plugin

Track Gauge Survey is a plugin for Trimble Access (based on the Windows or Android operating system). The application is installed via Trimble Installation Manager (TIM), available at https://www.trimble.com/installationmanager/. The control unit must have a valid Trimble Access license and a Track Gauge Survey license. Licenses can be obtained from info@trimble-railway.com by providing the serial number from the Trimble Installation Manager.

> **Note:**
> The minimum requirement for installing the application is Trimble Access v2021.10 for the Windows Version of the app and v2023.00 for the Android version.

Trimble Access Track Gauge Survey app

Starting the app and creating a project

Start Trimble Access from a desktop shortcut created during installation. Trimble Access (TA) opens and shows a list of jobs that can be navigated through. On the first start, there are no projects/jobs. After creating a new project and a new job with properties that apply to the job requirements, the Track Gauge Survey app can be started.

> **Note:**
> During the process of creating a Job in Trimble Access, the user has the possibility to specify a coordinate system. In case the TA Track Gauge Survey app is being used for measuring a track position for later monitoring of rail-specific parameters, it does not make a difference if a coordinate system was defined or if "Scale factor 1" was used.

Main- and Measurement menu

After creating a project and a job, the Track Gauge Survey app can be selected. In the app, the main menu can be opened by clicking the icon with three lines in the upper left corner.

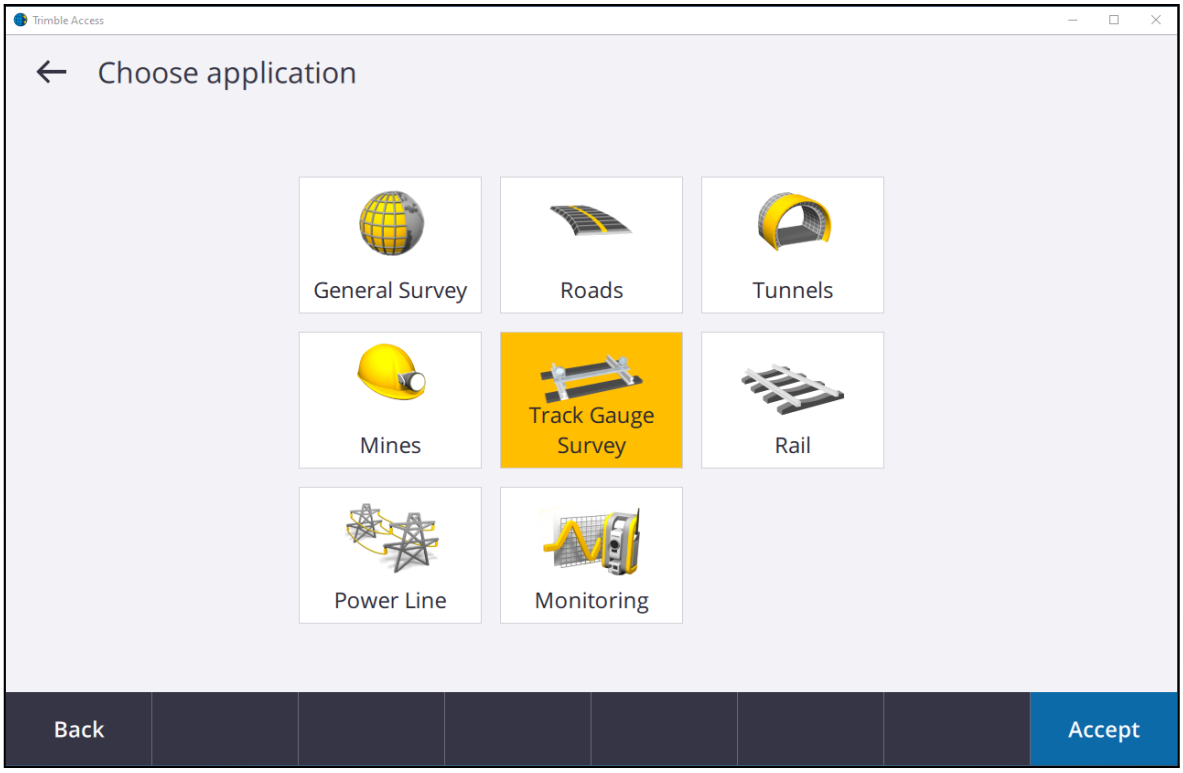

Figure 6: *Selecting the "Track Gauge Survey" app*

In the TA Track Gauge Survey main menu, the following items (numbered in red) are shown (Figure 7).

(1) Current project name

(2) Name of the active job

(3) Active favorites menu (+ opened window on the right)

(4) Menu for displaying the current job information

(5) Track Gauge Survey submenu title

(6) Selection window for all TA applications (Figure 6)

(7) Starts measuring with the track gauge

(8) Definition of the General Settings (design gauge, cant base, track gauge type).

(9) Measurement data output in “Complete track” or “Track” file format

(10) Back to last opened window (here: Map)

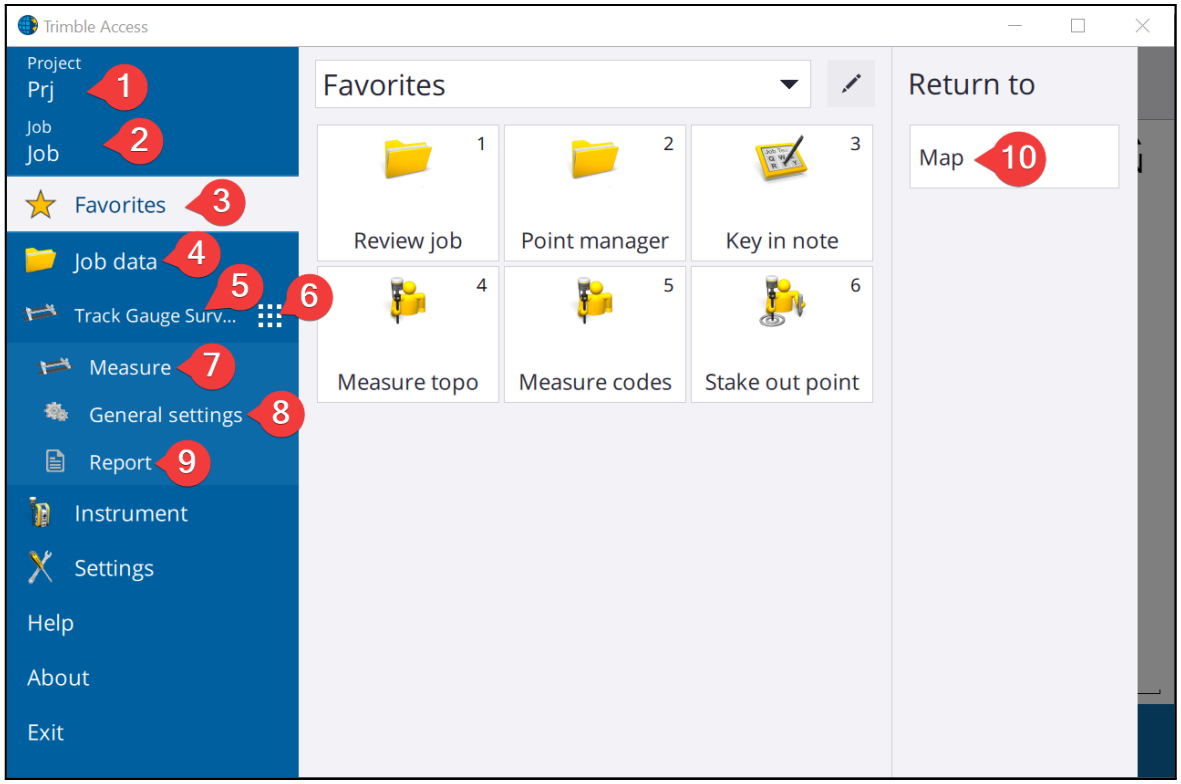

Figure 7: *The main menu of the Track Gauge Survey app with numbered functions.*

Clicking on ***Measure*** (7), followed by ***Measure track gauge*** in the submenu, starts a measurement. If no active survey is running yet, a total station is selected via the Survey Style. Afterward, either a valid station setup can be loaded, or a new one must be executed. The procedure is identical to the regular Trimble Access site setups. After setting up the instrument and site setup, the measurement menu with map functionality opens.

Brief description of the measurement menu in Track Gauge Survey (see Figure 7):

(1) Measure line name (track name)

(2) Point name (left/right point identical)

(3) Point code (left/right point identical)

(4) Chainage ascending/descending

(6) Display with a text description of the measurement process

(7) Discard measurement or exit measurement

(8) Measurement options (measurement method, target height, prism const.)

(9) Measure off track topo points

(5) Chainage (10) Start measurement

Map tools marked in green: Select, move, zoom, rotate, views, layers, settings.

Camera icon (in the green box at the bottom): Switch from the map window to the interactive total station video window.

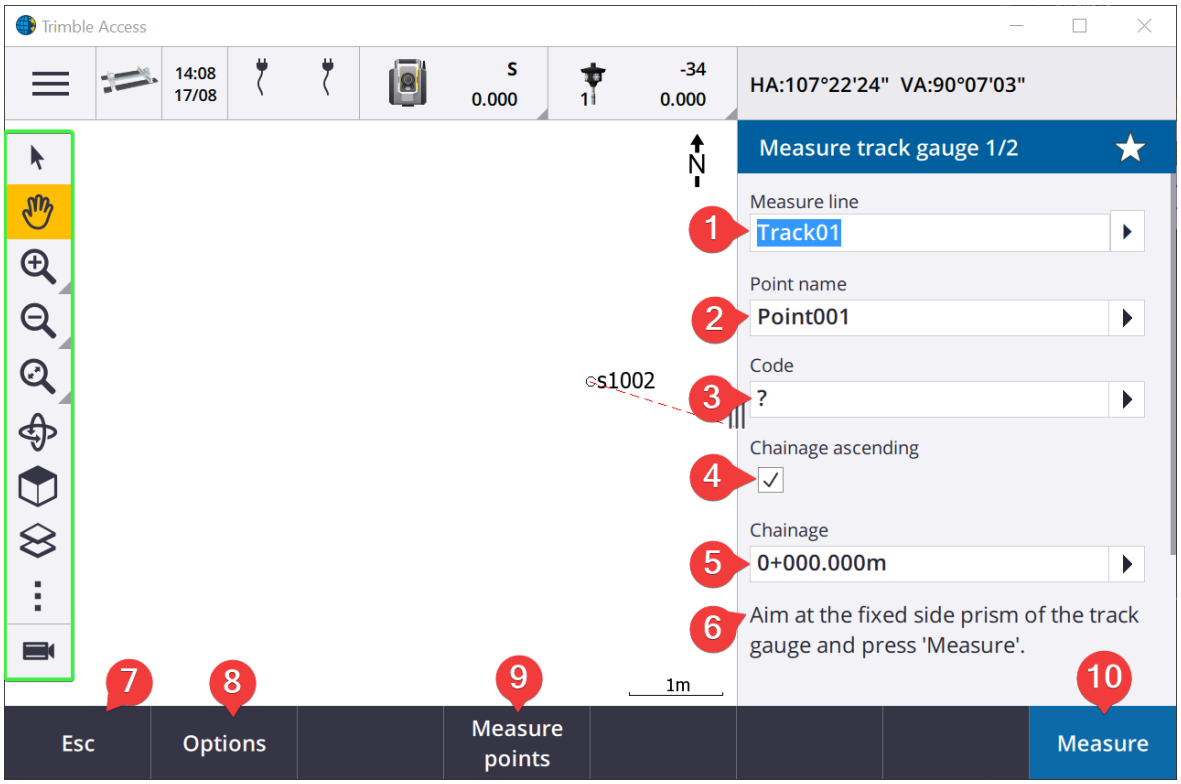

Figure 8: *Map window with measurement functions of the Track Gauge Survey app*

Measurements with the track gauge

The track gauge bar is placed on the track with the fixed side ("T-shape") pushed up against the rail running edge. This is done by rocking back and forth until the user ensures that the track gauge is aligned exactly perpendicular to the rail. This procedure is important to obtain a clear reference for measuring the track position. The opposite end of the track gauge is fitted with white plastic for insulation between the two rails. The side is placed loosely on the rail. This results in the designation of the two ends of the track gauge as the "fixed" side and the "movable" side, which will be used in the following descriptions.

Figure 9: *Description of the track gauge*

The track gauge is complemented with one prism over the fixed side and one over the movable side. This is where the name **"fixed" prism** and **"movable" prism** comes from. The measurement of the track gauge center point is not used in this application.

The software supports two types of track gauges. In the first type, both prisms are mounted at a fixed distance from each other. In the second version, the prism on the movable side is equipped with a spring-loaded stop that is pressed against the rail running edge. The track position and height as well as the cant can be calculated from the two measurements of the prisms. For the variant with a spring-loaded stop, the track gauge is also determined, whereas the gauge in the simple variant (both sides fixed) is always a fixed value.

Note:
The prism on the movable side is still called "**movable**" if the track gauge with two fixed prisms is used.

Note:

The distance between the two prisms is compared with the project's design track gauge for each measurement. If the deviation is too large (+/-5cm), a warning is issued. This way, point mix-ups can be avoided.

General settings in TA Track Gauge Survey app

Project-based settings are defined in the General settings. With the start of a new project, the cant base, reference gauge, and track gauge configuration are queried before measuring. If no settings have been specified, they must be defined before the first measurement.

The track gauge can either be equipped with two prisms fixed on the track gauge (Both prisms fixed) or a configuration where one is fixed, and one is movable (Fixed and movable prism), in which case the gauge is measured at the same time.

Be aware that after clicking "Accept," the parameters can no longer be changed within the project, so the parameters should be chosen with due care.

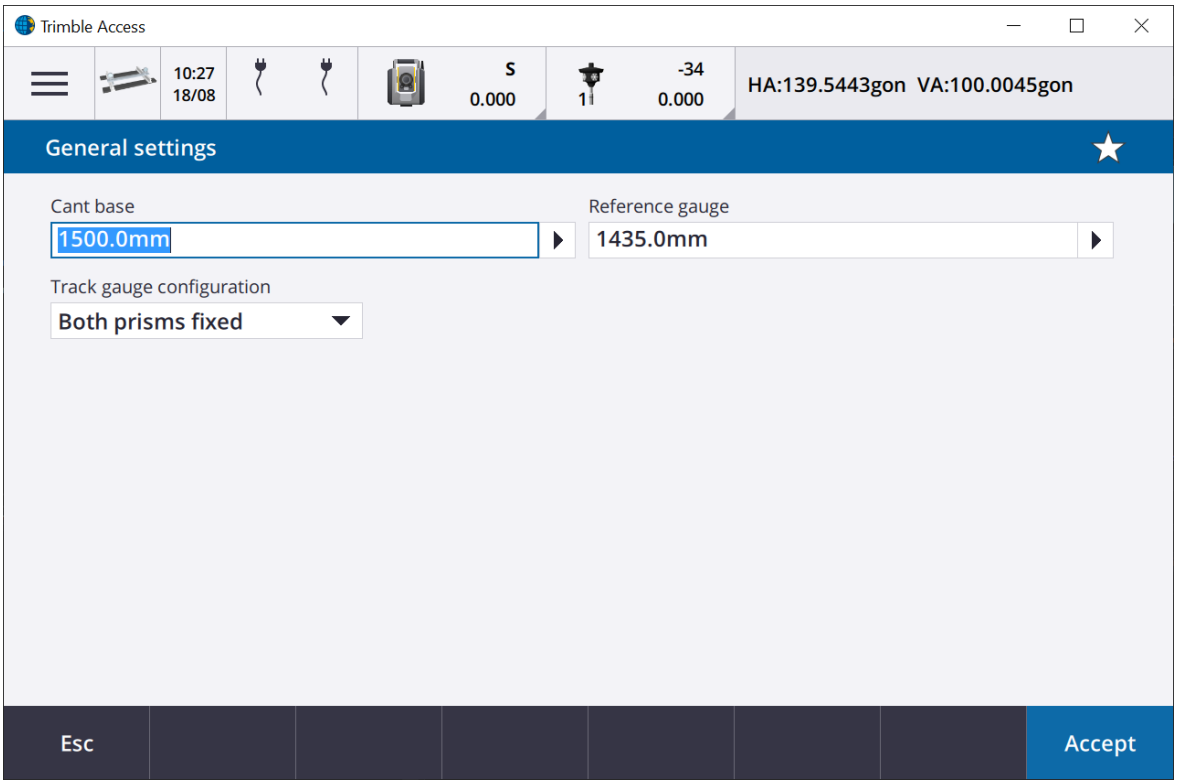

Figure 10: *General project settings in TGS*

Measure settings

Before starting the measurement, the ***Measure Settings*** should be checked (see Figure 11). The auto point step size, the checkbox: empty code field after storage, the measurement order as well and the prisms with their vertical (not perpendicular!) heights are defined. When a prism is selected, the system dialog for prism selection opens.

Note:

As of software version 1.0.2, the user can also measure in both faces by selecting so in the measurement settings - Auto F1/F2 setting (see Figure 11).

In Figure 11, "Target 1" (referring to the first target of the prism list, not its name) is selected for the prism above the fixed side, and a target height of 10 cm is defined. The second prism (movable side) also has a target height of 10 cm. However, since a different prism constant was used, a different target, "Target 2", can also be selected. If the same prism settings are used for both sides, the same target (e.g., "Target 1") can also be selected twice. Clicking on one of the two buttons takes you to the standard TA dialog for prism selection or definition.

Note:

The prisms can be freely selected from the list of available prisms. However, **their target heights are ignored** during the measurement and are set to 0 in the general prism definition as well as in the TA system dialog . The actual vertical target height of the prisms is managed by the application in the measurement settings and attached to the measurement. When clicked on ***Accept***, the settings are accepted. Changing the measurement sequence discards an individual measurement that has already been started.

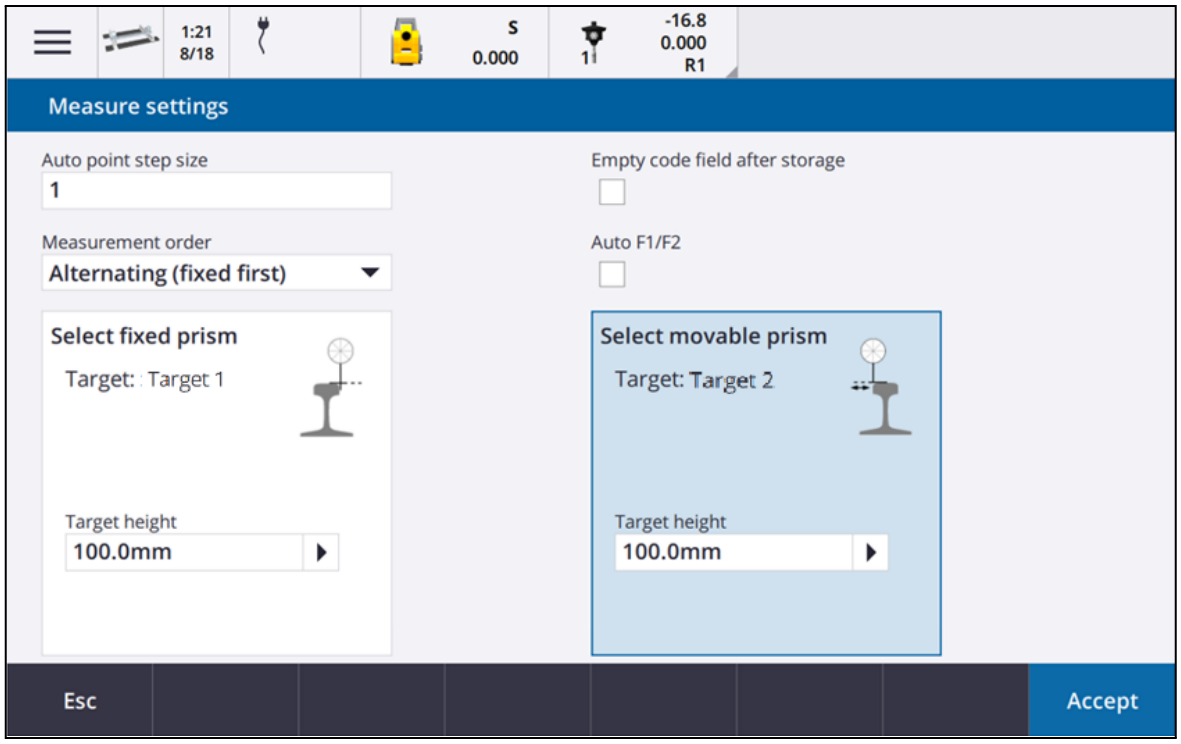

Figure 11: *Dialog for defining the measurement settings*

Measuring procedure

A measurement sequence always consists of one valid measurement for each of the two prisms for each track gauge position. If only one prism is visible, this position cannot be saved. The available measurement methods are explained in Figure 12. Diagonal dashed ins indicate a re-aiming of the total station.

For **A) fixed side first**, the fixed prism (1) is targeted first, followed by the prism on the moving side (2). At the following track gauge position (chainage), the fixed side is again targeted first and then the moving side.

At **B) movable side first**, first the movable side, and then the fixed side is measured. At the following track gauge position, the movable side is still measured first, followed by the fixed side.

The third option, **C) alternating (fixed side first)** with the fixed side first measured, is recommended for efficiency reasons. Here, at the first position, the fixed side is measured first, and then the movable. At the next position, the measurement starts with the movable side and ends with the fixed side. The measurement of the third point is analogous to the first. A) and B) require more frequent re-targeting. C) saves one aiming per change between two track gauge positions, hence it saves time.

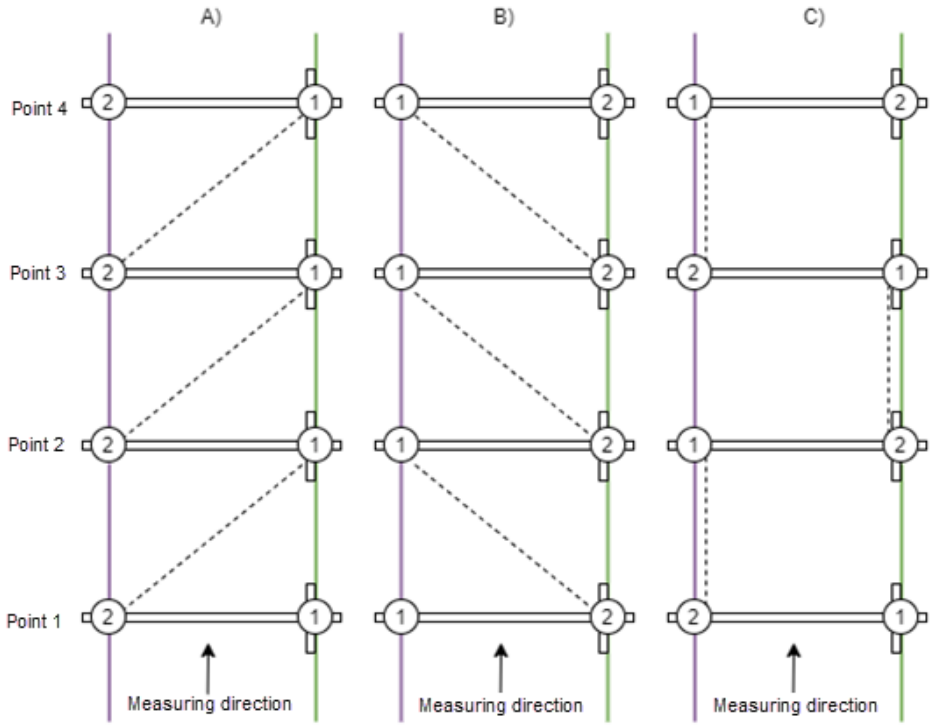

Figure 12: *Visualisation of the measuring procedure with the representation of the track gauge's fixed and movable sides*

Automation

Prerequisites: The first two recorded points of measurement define the chainage direction. In the chainage direction, the calculation is ascending or descending, depending on the setting. The first two points should not be too close to each other. The recommended minimal distance is 3m so that a meaningful direction angle in station direction is created.

Autolock is a basic requirement for prism tracking to work correctly. A video total station simplifies aiming. Tracking further accelerates the measurement process. Therefore, it is recommended to use both settings. In tracking mode, the chainage value is updated automatically.

Tip: If it is necessary to enter a new chainage value, the tracking mode must be switched off, and the new chainage value must be entered. The tracking mode must then be switched on again after measuring the first point.

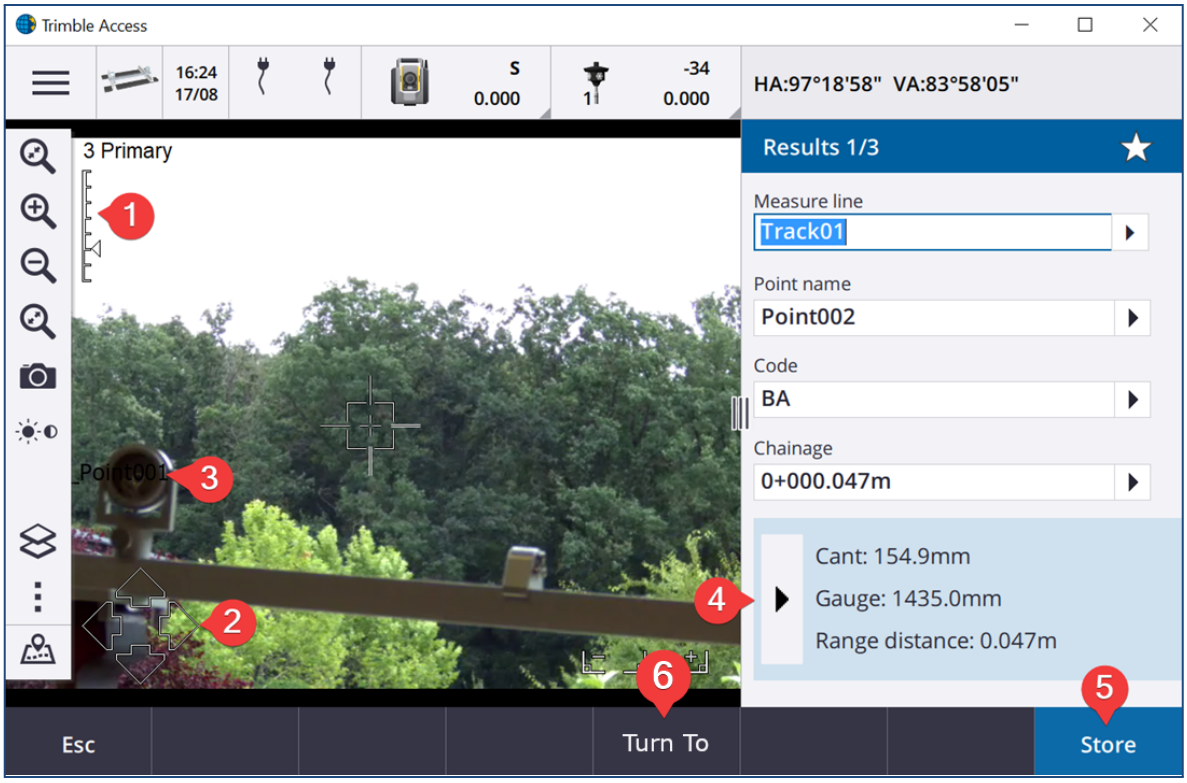

Figure 13: *Display of the results window with total station control (1) zoom, (2) rotation, prism (3), and button (4) to view different results.* ***Store*** *(5) saves the results*

Using "Turn to": After two track gauge positions have been saved (two chainages measured), the "Turn to"(6) function for automatic prism change appears at the bottom of the measuring menu. From the third position, this function can be used to switch to the second measuring point automatically.

The partially automated measurement sequence is thus:

- Walk to the next chainage, tracking the prism by auto-lock,
- ***Measuring*** the first point
- ***Turn to***
- ***Measure*** the second point
- Results are displayed ***Store***.

Afterward, you can go to the next point again, and the procedure is repeated. By clicking on ***Esc*** in the result display, a measurement can be discarded. Pressing ***Esc*** again ends the measurement and closes the measurement window. The measurement (site setup) can be ended via the ***Main menu*** → ***Measure*** → ***End survey***.

Data output

Complete Track

The data output is possible by clicking on ***Report*** in the main menu. Complete Track exports a column-oriented comprehensive format with all measurement data of the current job. For the output, the file name, the height reference, the positional reference, and the decimal separator can be specified. The references can be selected between the rail running edge and the middle of the rail head. Typically, the height refers to the center of the rail head, and the track position refers to the rail running edge. The setting for the decimal separator "." provides the classic comma separation of the CSV format. The setting with a "," as a decimal separator results in the output of a semicolon-separated CSV format.

Track file

In the main menu ***Report*** → ***Track File,*** a 3D representation of the entire actual track position in a non-readable binary format can be exported. This file is being used in Trimble 4D Control to calculate offsets from the measured prism to the top of the rail head. It is also used to pass the measurement data internally to other Trimble programs, such as Trimble GEDO Office, which can then make further calculations or generate export formats based on the track file.

A separate file must be exported for each measurement line (for each measured track). The file name corresponds to the name of the measurement line and is adjusted each time a new entry is selected from the list of available lines. The name can still be changed afterward. Apart from the file name, no other settings are necessary. The file extension is ****.track***.

Note:

If measurement points from different tracks were accidentally saved in a measurement line, the track file may not be generated because internal algorithms do not support sharp bends. The line name can no longer be edited in the project, so the affected points must be deleted in the main menu under the Review job to be able to generate the file.

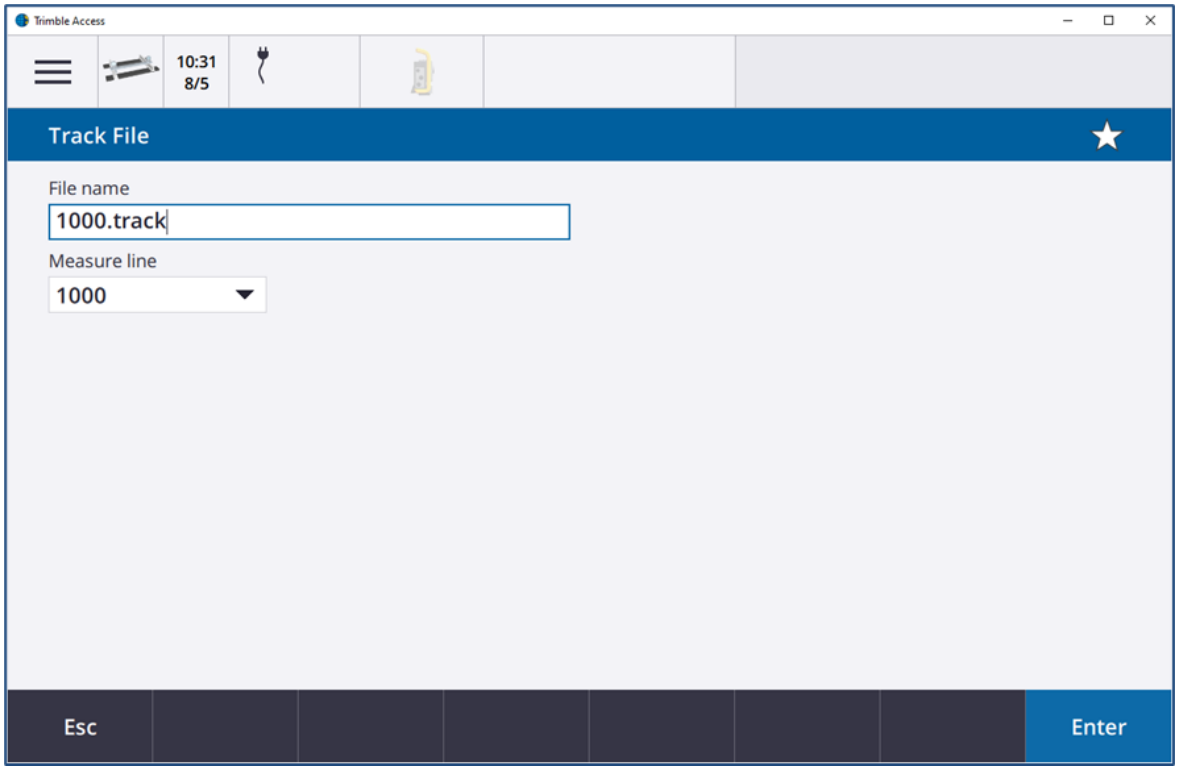

Figure 14: *Export dialog for survey output of the results in the* ***Track File*** *format*

As-built survey - Trimble GEDO CE 2.0 measurement system

Another solution for collecting the as-built survey data is using the GEDO Trolley in combination with Trimble S Series instruments, Trimble Access Rail GEDO Rec or GEDO Track app. The Trimble GEDO CE 2.0 track measurement trolley is the main unit of the modular Trimble GEDO track measurement systems, which can be used for geodetic track surveying. It consists of the Trimble GEDO CE 2.0 track measurement trolley with a Trimble control unit in combination with a Trimble total station. The same applies to the Trimble GEDO Track system, and the only difference is that the correction values (if the design data is available) are displayed live on-site when using the GEDO Track app.

GEDO Office is a software used for further analysis and processing of TA Rail GEDO Rec and Track measurements. This is where the ***.track file**, necessary for monitoring purposes, can be exported.

Further information regarding the GEDO measurement system can be found at https://gedo.trimble.com/en. Detailed information, manuals, support notes, and more can be found in the Download Center. Registration is necessary.

Figure 15: *GEDO CE 2.0 measurement system*

Rail Monitoring prism solution

There are four recommended ways to install the prisms for rail monitoring purposes. The user has the flexibility to install the prisms based on the applicable environment, project, or country specifications.

One of the solutions is gluing the prisms on the rail itself. Using the mounting plate, the prisms can easily be fixed on the rail by means of mounting adhesively. After the monitoring project is finished, the prisms can be removed easily and, if needed, re-affixed. A similar approach to this one is fastening the magnetic prisms directly on the rail.

Figure 16: *Prism glued on the rail*

Another way is fixing the prisms on the sleeper. Depending on the type of sleeper (steel or concrete), the prisms can be screwed or glued on the sleeper.

Figure 17: *Prism glued on a steel sleeper*

Prisms can also be fastened on the rail itself using the rail clamps. Rail dimensions must be known so that the rail clamp can be installed.

Figure 18: *Prism fastened on the rail*

Measuring monitoring prisms

In case it is desired to collect the coordinates of the monitoring prisms (installed along the track) right after the track measurement, this can be done directly in the TA Track Gauge Survey app, where these are then measured as topo points. Starting the topo measurement can be done directly from the measurement window in the Track Gauge Survey app by clicking on ***Measure points*** at the bottom of the measuring menu or clicking on the ***Menu symbol***, followed by ***Measure*** → ***Measure points***. In both cases, the Trimble Access Track gauge Survey app automatically switches to the General Survey module. In the measure topo window, the point name and, if desired, the code can be defined. Monitoring points can then be measured one by one, giving a corresponding name and code for each point.

After all of the points are measured, the *.CSV file containing only the coordinates of the monitoring prisms can be exported. After clicking on the menu symbol  and selecting the current job at the bottom of the measuring menu, the ***Export*** softkey can be found. This gives the user the possibility to export different file formats. For monitoring purposes, the file format ***Comma Delimited (*.CSV, *.TXT)*** should be selected.

To have the right order in the *.CSV file (for the later Import into the T4D Server), an appropriate field for each value must be selected:

- Field 1 → Point name,
- Field 2 → Northing,
- Field 3 → Easting,
- Field 4 → Elevation,
- As a Field delimiter, select <,>.

After clicking on ***Accept***, the following window offers different possibilities to export the points. There are a few ways to export only the monitoring points for the rail monitoring project:

- Select from the list
  - Manually select only the monitoring prisms points
- All points with the same code
  - In case monitoring points were measured with the same code, the code can be defined, and all of the points exported together in one CSV file
- Points by name range
  - In case monitoring points have the name for which the name range can be defined, type in *From point - To point* range
- Section of job
  - Select *From point - To point*
- Map selection
  - Select the monitoring points directly from the map

General Workflow

Setting up and creating the rail monitoring project in the field and the office consists of following parts:

- **Trimble 4D Control Server**

  1. Selecting the Coordinate System valid for the rail monitoring project

  2. Setting up the measurement round using the Settop M1/T4D Sever or uploading the *.CSV file with the coordinates of the monitoring prisms (see Measuring monitoring prisms)

  3. Performing the station setup

- **Trimble 4D Control Web**

  4. Creating the project

  5. Adding the sensors in T4D Web

  Advised

  a. Creating the users to be informed when unwanted parameter change happens

  b. Configuring a general alarm for all the prisms involved in the rail monitoring project

- **Rail Monitoring module**

  6. Creating the Rail monitoring section

  7. General tab

  8. Track geometry tab

  9. Chainages tab

  10. Parameters tab

  11. Recipients tab

Trimble 4D Control Server

Rail monitoring is part of terrestrial monitoring, which can be described as the monitoring of a structure over time. In this case, the structure is the rails. Trimble recommends using a Settop M1 Total Station Controller to manage and control the total station. The data is then transferred to Trimble 4D Control installed on a local Windows or Azure server. In Trimble 4D Control (T4D), the measurements are checked, corrected, adjusted, and stored in an SQL database and can be displayed on the T4D Web for analysis, reporting, and alarming.

Setting up a project in Trimble 4D Control Server

Coordinate system

The first step when starting the monitoring project in Trimble 4D Control is to select the coordinate system. This can be done by clicking on the ***File*** → ***System properties*** → ***Coordinate System***. A new window opens, and the ***Coordinate System and Zone*** can then be selected from the Coordinate System Group. By clicking on Next, the Geoid model can be selected.

Note:

The user has to be familiar with the coordinate system the data is in, and this coordinate system must be selected in T4D. Among other things, it is important to be able to use the map functionality in the Trimble Control Web application.

Automated Monitoring using the Settop M1 and TA Track Gauge Survey app

The Settop M1 controls the total station and measures the defined round. In this case, rail monitoring prisms are being measured. These rounds are then downloaded by the T4D Data Collector module. Another way to define the round measurement is by using the T4D Data Collector module. After the round is completed, the station setup definition must be done. This is being done in the T4D Data Collector module.

It is also possible to import the coordinates of measured points from a CSV file. Using the Trimble Access Track Gauge Survey app (which switches to the General Survey app for topo measurement), the user would measure the railway track described in paragraph Measurements with the track gauge, followed by measuring the installed prisms as topo points. The result when using the TA TGS app is the *.CSV file containing coordinates of the installed prisms and the *.track file containing all track geometry parameters. The CSV file is then imported into the T4D Server, and the station setup is done in the T4D Server.

The *.track file, exported from the Track Gauge Survey app, containing all track geometry information, is imported into T4D Web for further calculations of the rail geometry parameters.

Every following new measurement of the monitoring prisms is then automatically processed in the T4D Server and used in the T4D Web Rail monitoring module to further calculate the rail geometry parameters.

Note:
In case two or more total stations are being used for one rail monitoring project, network adjustment must be done, i.e., all of the Data Collectors have to be selected in the same Terrestrial Engine.

TA Monitoring app + TA Track Gauge Survey app (semi-automated)

In this combination, the user uses the TA Monitoring app to do the site setup and to measure monitoring prisms in the field and the TA Track Gauge Survey app to measure the track itself. One way to go from here if the user is setting up an automated system is to transfer the site setup definition and the measured round (directly from the app) to Settop M1 to start the fully automated system.

If the user is performing semi-automated monitoring, then the TA Monitoring exported ***.tamsetup*** file can be imported into the Data Collector in the T4D Server, containing the **site setup** and the **coordinates** of the monitoring prisms.

Every following new measurement of the monitoring prisms is then exported from the TA Monitoring app and manually imported into the T4D Server.

The ***.track file***, exported from the Track Gauge Survey app, containing all track geometry parameters, is imported into T4D Web for further calculations of the rail geometry parameters.

Semi-automated monitoring is also possible using manual data entry in the T4D Web application. After creating manual sensors in T4D Web, measurement data can be manually uploaded and automatically applied to the rail section containing those sensors. To learn about this solution, see Trimble 4D Control Web User Manual (Section 6).

Other supported file types containing measurement data that can manually be uploaded in T4D Sever are Job XML (*.jxl) and GKA files.

Trimble 4D Control Web

Creating the project

To add a new project, click on the green + button in the header row of the Project Listing page. This navigates you to the Add Project page. On the ***Add Project*** page, it is possible to:

1. Specify a ***Project Title*** (required).
2. Add a ***Description*** (optional)**.**
3. Select a ***Timezone*** (required).
4. Go to the ***Unit Preferences*** tab to configure display units.

Once satisfied with all the values, you can click on the ***Save*** button. Alternatively, you can click on the ***Cancel*** button.

Note that the newly created ***Project*** will automatically be set as the new ***Current Project***. When a new ***Project*** is created, the ***Coordinate System Definition*** is read from the ***Trimble 4D Server*** and applied to the new ***Project*.** If the ***Coordinate System Definition*** in the Trimble 4D Server is changed after the creation of a ***Project,*** then the ***Project Coordinate System Definition*** may have to be updated.

Adding sensors into T4D Web

The ***Target (Displacement)*** sensor type represents the change in ***Coordinates*** of a specific prism over time. Since T4D version 6.4, the new data type Coordinates is available for the sensor type ***Target (Displacement)*** and ***GNSS***. For rail monitoring purposes, data type Coordinates and Terrestrial displacements are going to be used.

The fastest way to add multiple sensors in T4D Web is through the ***Projects*** window in the ***Administration*** tab. To begin this process, click on the ***Add Multiple Sensors*** in the ***Project Manager*** tab**.** On the ***Sensor Type*** tab, select the ***Target (Displacement)*** sensor type. If the Rail monitoring module license is available, the ***Coordinates*** as the data type is going to be selected automatically.

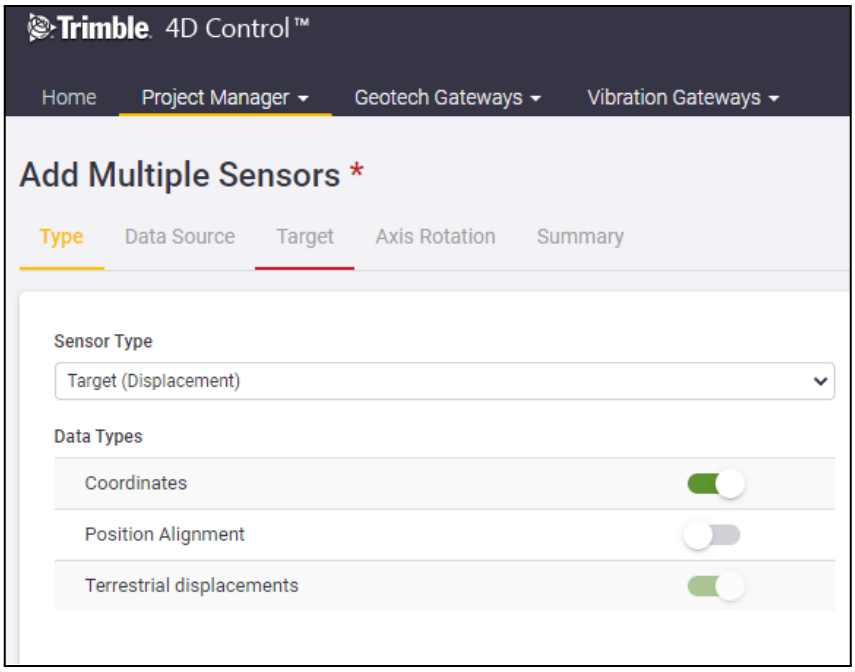

Figure 19: *Data types for Target (Displacement) Sensor Type*

You can proceed to the next tab by clicking on it or clicking on the ***Next*** button.

The drop-down on the ***Data Source*** tab will contain a list of all the position modules in the ***T4D Server***. Select the desired one and click on the ***Next*** button.

The ***Target*** tab consists of a grid or table showing all the ***targets*** (or ***prisms***) associated with the selected ***Data Source*****.** By default, all the ***targets*** will be selected, and a default sensor name will be suggested based on the ***Target Name***. You can select or deselect the individual ***targets*** that should be imported. You can also edit each sensor name individually or specify a ***Prefix*** and/or ***Suffix*** to be added to the auto-generated names. Additionally, you have the option to import historic observation data (if available).

Note:
It is advised to use prefixes and meaningful naming for the monitoring prisms (sensors) applicable to the track that is being monitored. This can be very beneficial in the rail switch area, where two or more tracks come together. This early elimination of sensors based on a name prefix and its connection state offers the opportunity to the user to exclude certain sensors from the detection algorithm.
This can be done here in T4D Web while creating the sensors or in the field while measuring.

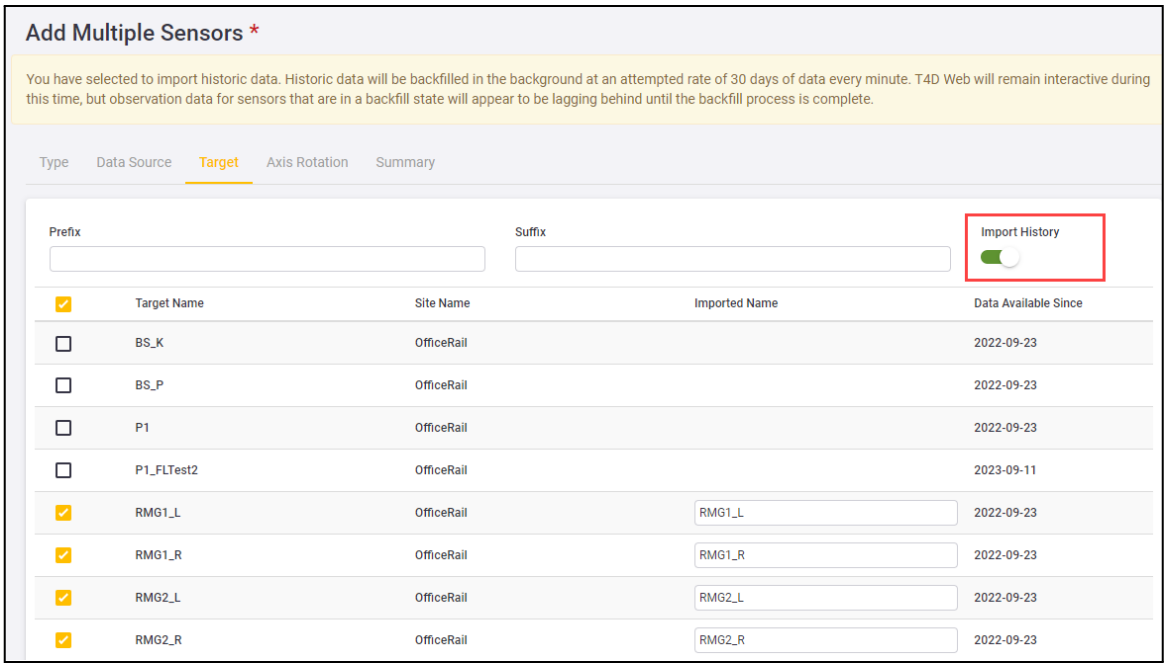

Figure 20: *Importing history data*

Rail module allows the utilization of historical data for parameter calculations. To import historical data, simply activate the 'Import History' button when adding sensors in T4D. After that, during the Rail section creation workflow, ensure that you select the preferred reference point (see Figure 24 for guidance). This feature proves beneficial when you need to retroactively choose the ideal starting point for monitoring, enabling users to navigate back in time and accurately start monitoring from the desired historical data point.

The ***Rotation Angle*** of the targets can be configured on the next tab. Click on the ***Next*** button to proceed to the ***Summary*** tab.

Review the details on the ***Summary*** tab and click on the ***Save*** button.

A progress bar will appear at the top of the page. The ***Target*** (***Displacement***) sensors will be created and connected to the selected ***Data Source***. It is important to keep your browser open and to remain on the current page until the process completes. When all the sensors have been created and connected, you will be navigated back to the ***Sensor Listing*** page.

Rail Monitoring Module

The Rail Monitoring module can be found under the Monitoring tab in Trimble 4D Control admin web.

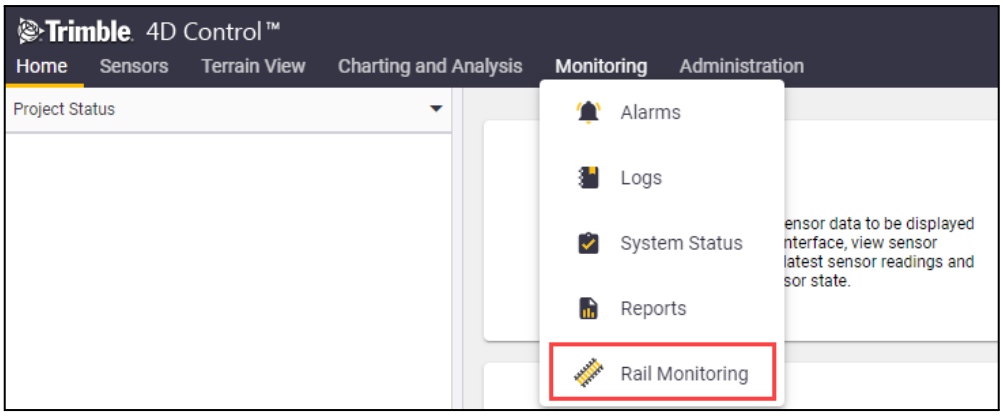

Figure 21: *Rail Monitoring Module in T4D Web application*

Rail section

Rail section is the representation of the rail monitoring project in the field, containing all of the rail track geometry parameters, which are calculated using the data collected in the field, automatically or manually, with total station or tiltmeters.

Figure 22: *Rail section window*

The main components of the Rail section are:

1. Rail section **Status** ⟶ fast way to see the status of the rail monitoring section
2. Rail section **Name**
3. **Sensor type** ⟶ Either Target or Tiltmeter
4. **As-built survey** ⟶ Whether or not an as-built survey was used
5. **Cant basis** information
6. **Chainage range**
7. **Number of chainages**
8. Button to **Enable** or **Disable** the Rail section (editing the Rail section is only possible if the Rail section is Disabled)
9. Rail section **Status** ⟶ takes you to the tabular view
10. **Charts by Chainage**
11. **Charts over Time**
12. **Reports**
13. **View/Edit** Rail section (depending on whether the Rail section is enabled or disabled)
14. **Delete** Rail section
15. **Refresh Rail sections**
16. **Add new Rail section**

Creating the Rail section

Rail section can be created by clicking on the ***Add new Rail section*** button  in the Rail Monitoring module. There are three ways to create a section: AMTS Rail Monitoring With an As-Built, AMTS Rail Monitoring Without an As-Built, and Rail Monitoring with Tiltmeters. There are five main steps when creating the Rail Monitoring section.

AMTS Rail Monitoring with As-Built

General

This is where the Rail section name, sensor type, use of as-built, height reference, twist output, units for the chainage, rail geometry parameters (cant, twist, horizontal and vertical displacements, horizontal and vertical versines), and observation age have to be defined. The **Sensor Type** specifies if targets (prisms) or tiltmeters are used. The **As-Built Survey** button is where the user decides if the collected as-built survey data is going to be used for the offset and parameter calculation or if there is no as-built survey data available. The as-built data is written in the *.track file. **Height Reference** specifies if the left or right rail is used as a reference for the height. **Twist Output** tooltip allows the user to select how the twist will be expressed (see Twist).

Select the desired units and decimals and click on the **Next** button.

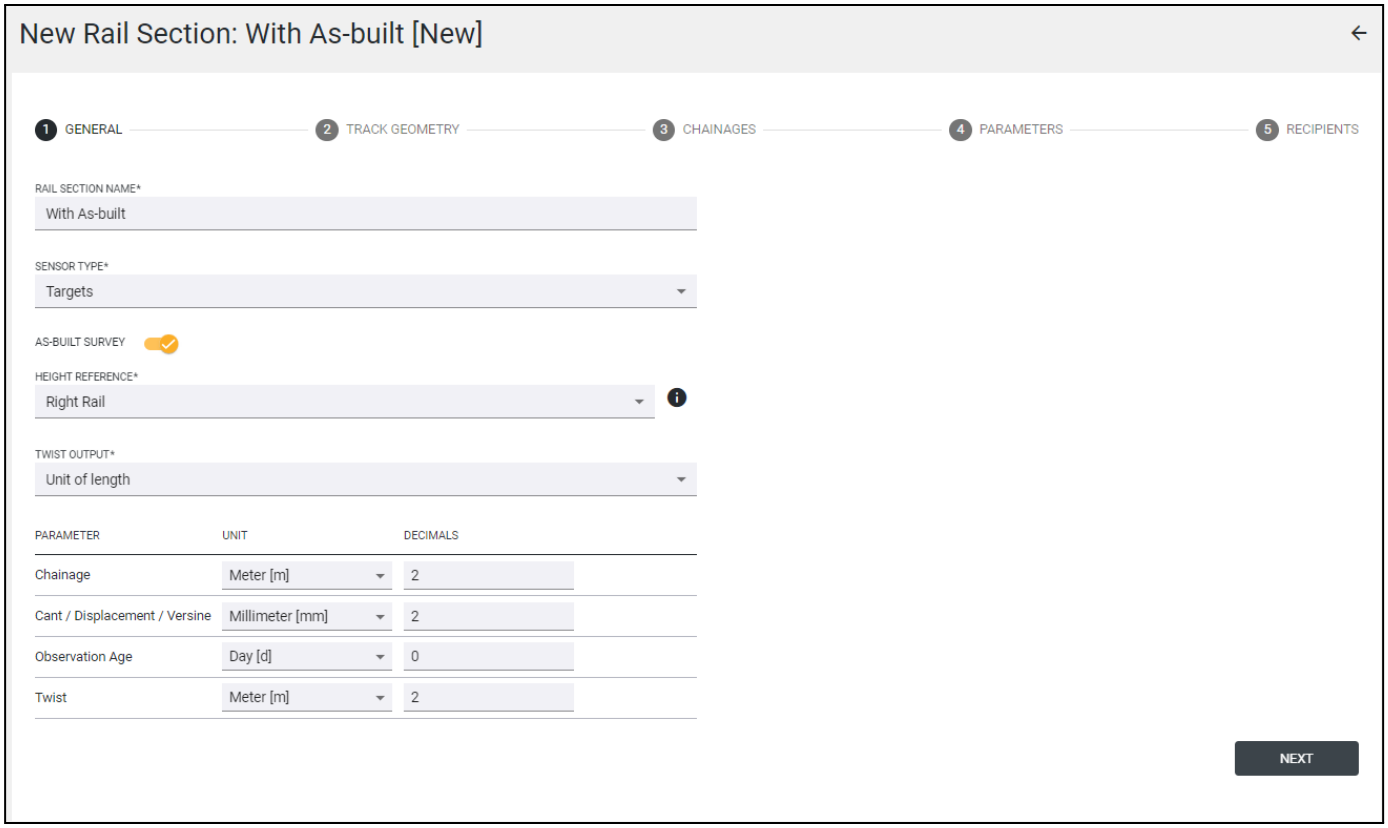

Figure 23: *Creating rail section - General tab*

Track geometry

The Track Geometry window is where the user has to upload the ****.track file***. There is an information button that gives a short description of the file. Additionally, cant basis and chainage range information from the file is shown in the window. After uploading, click on the **Next** button.

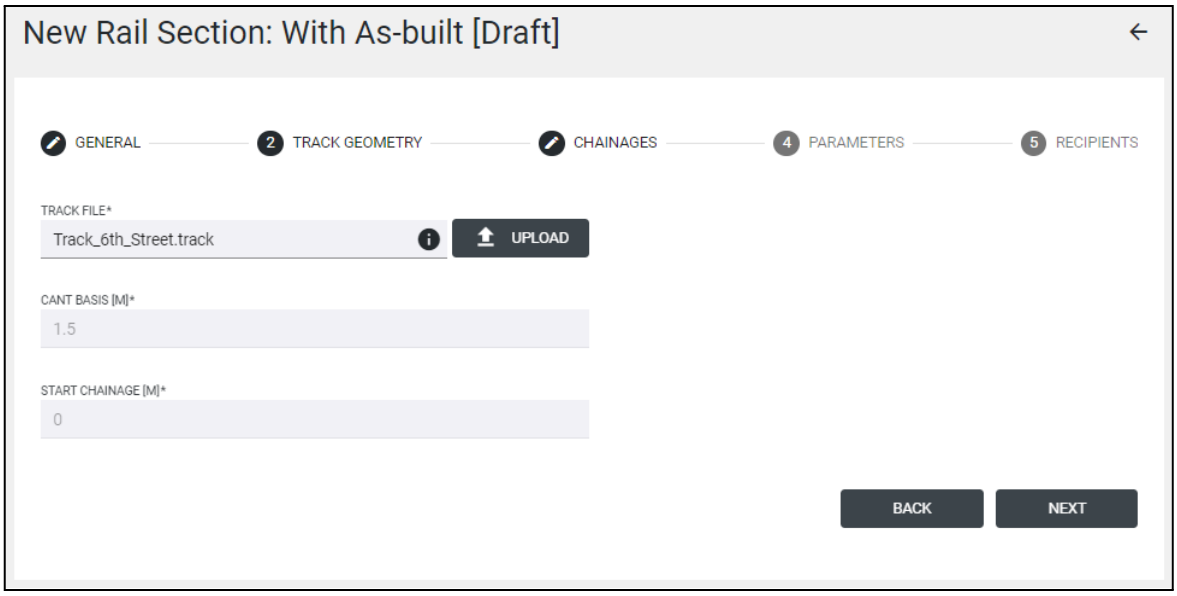

Figure 24: *Geometry Window - AMTS Rail Monitoring with As-Built*

Chainages

In the next step, the data from the ***Track file*** and the sensors added in T4D come together, and T4D shows auto-detected sensor pairs along the ***Rail section***. Based on the chainage information from the track file and the coordinates of the prisms, prism pairs are created. In addition, the user has the possibility to set the **Reference Date** (defaulted to "Now"), specify an optional ***Sensor Prefix***, and re-run the detection. This is helpful in case there is a measurement round in which not all prisms were measured (e.g. when the train is passing) or there is inconsistency in the available data (e.g., windy weather).

If the chainage is not necessary for the monitoring project, it can be deleted.

Note:
It is advised to use prefixes and meaningful naming for the monitoring prisms (sensors) applicable to the monitored track. This can benefit the rail switch area, where two or more tracks come together. This early elimination of sensors based on a name prefix and its connection state allows the user to exclude specific sensors from the detection algorithm.
This can be done in the field while measuring or in T4D Web while creating the sensors.

The values in the ***Reference Date*** fields are used to find "Reference Coordinates Observations" for each sensor during the detection. The optional value entered into the ***Sensor Prefix*** can filter specific sensors in or out when detecting sensors associated with the specified railway track.

Figure 25 shows the sensor pairs detected along the Railway section.

- The "Chainage" column shows the chainage value (along the track axis) associated with each sensor pair.
- The "Interval" column shows the chainage value increment from the previous station pair to the current pair.
- The "Left Sensor" and "Right Sensor" columns show the prism names of the sensors on the left side and the right side detected at each Chainage.

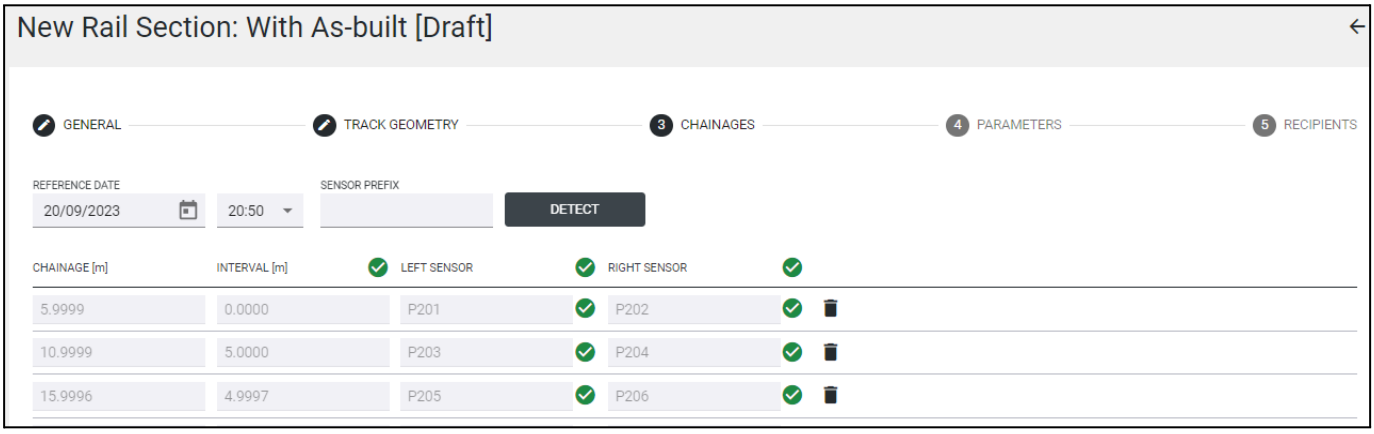

Figure 25: *Track Geometry Window - AMTS Rail Monitoring with As-Built*

It can happen that not all prisms were measured during one measurement round. If so, the following symbol is shown next to the sensor,  indicating inconsistency.

Inconsistent Chainage Interval

This warning highlights the scenario where T4D does not have any coordinates observations for one of the prisms installed on the railway line. This warning is intended to inform the user that it is possible that one of the installed prisms has never been measured.

Inconsistent Reference Measurement Date

This warning highlights that not all of the measurements come from the same round measurement. Users must determine whether action should be taken or whether these warnings are explainable and/or acceptable. In other words, the user can accept this inconsistency and continue, or specify a later reference date and press ***Detect*** once more.

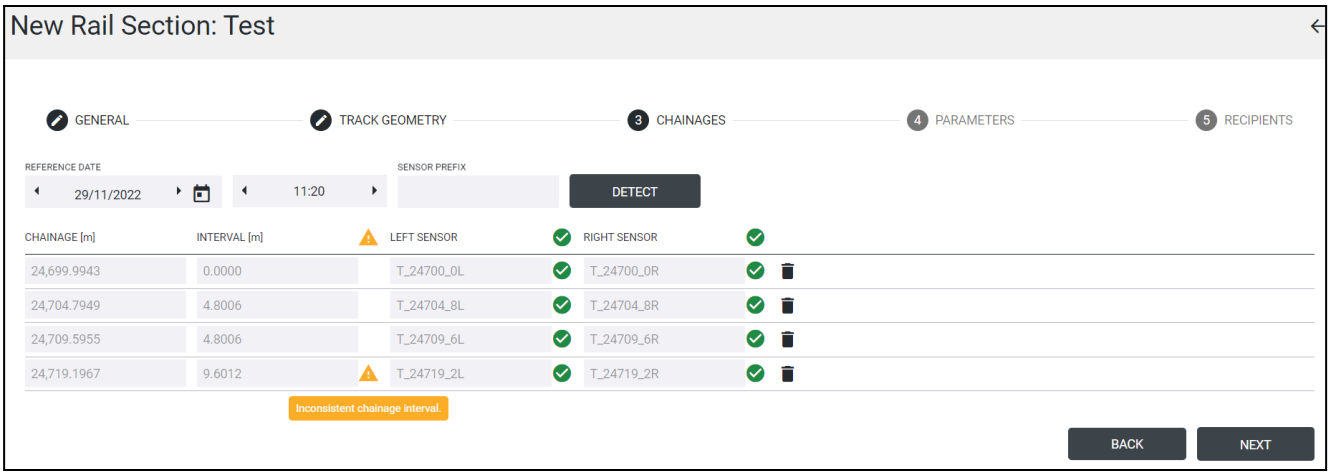

Figure 26: *Creating rail section - Inconsistent Chainage Interval*

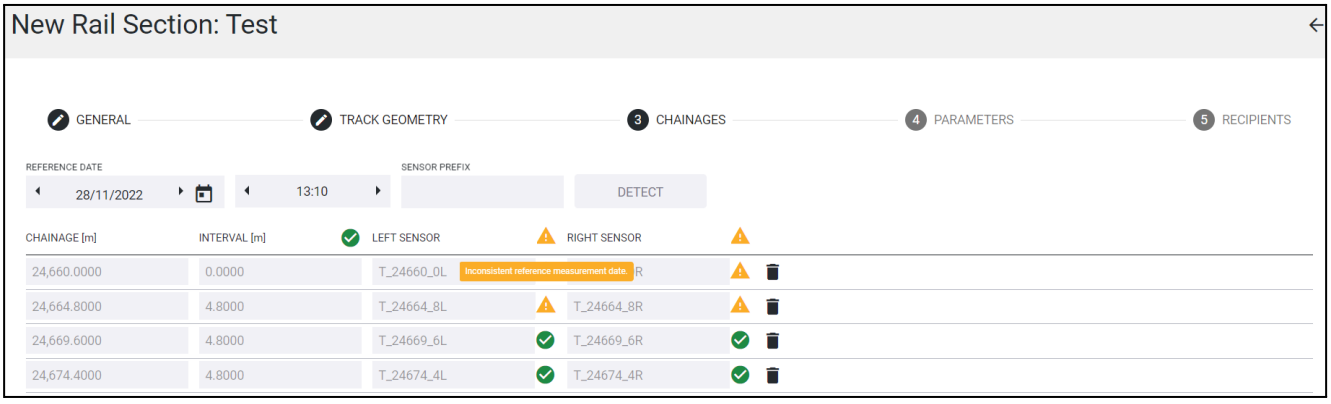

Figure 27: *Creating rail section - Inconsistent Reference Measurement Date*

The icons / can be clicked on to view the lateral and height offsets for each sensor, as well as the Reference Observation Date of the Coordinate observation that was used to calculate these offsets.

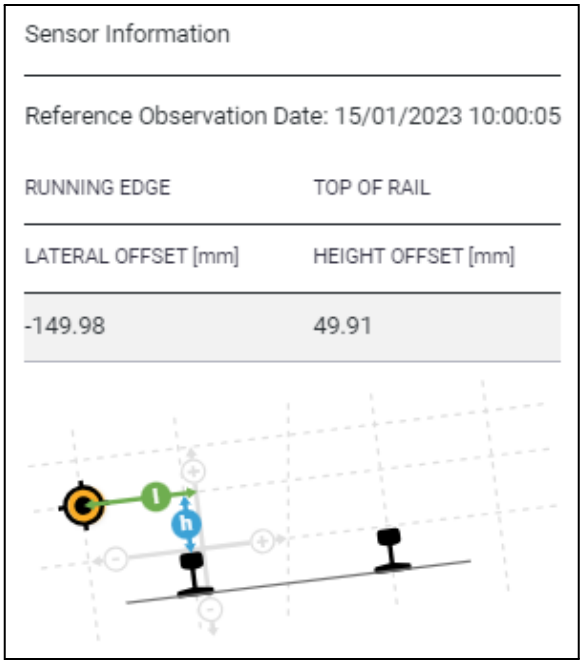

Figure 28: *Sensor Information window*

Parameters

Parameters tab is where the user chooses which parameter should be monitored (monitor button). After enabling the monitor button, a threshold for attention, warning, and alarm must be entered.

If the parameter should not be monitored and alarmed on, but the user is interested in seeing how the value is changing, the parameter can only be displayed (show button).

Note:

As of T4D 6.5 version, the user can calculate and monitor displacements and versines for the track centerline, left rail, or right rail (in version 6.4 only the track centerline was possible).

The information button next to the parameter name gives us information about the parameter (see Figure 29).

Note:

If the thresholds are defined and changed after that, the values in the Rail section status and in the charts will only change after the next measurement round.

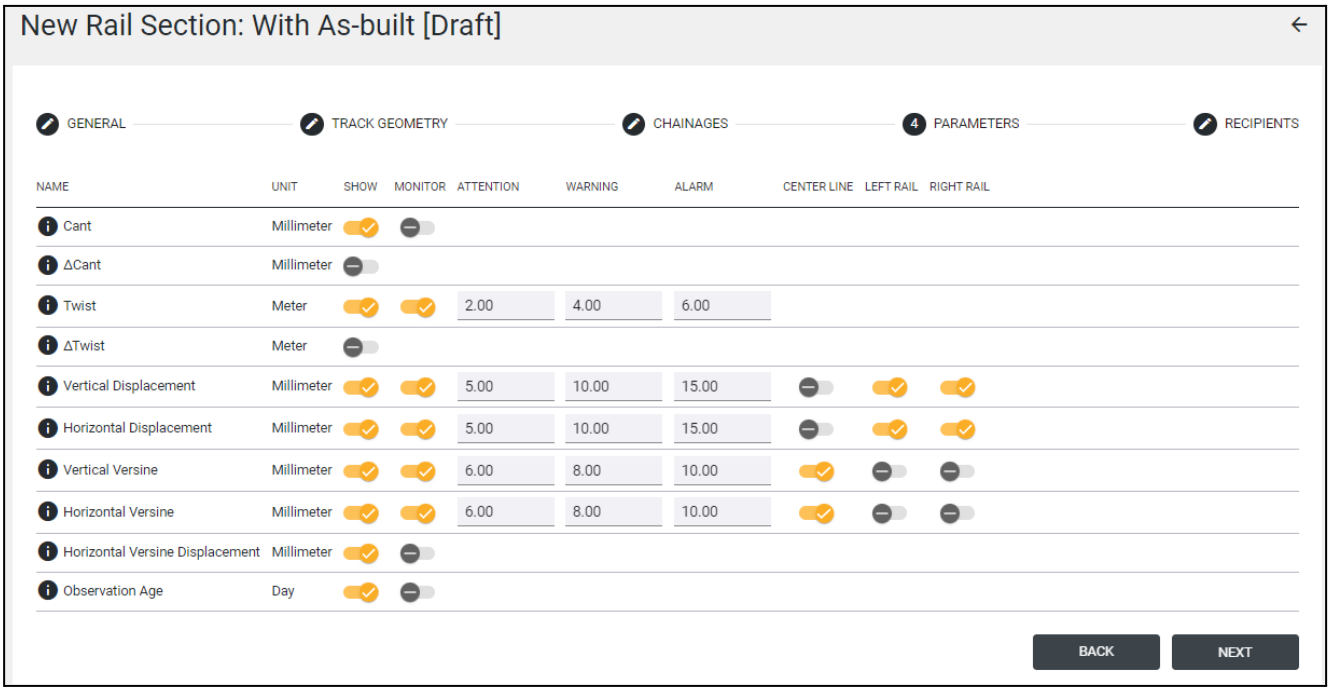

Figure 29: *Parameters Window - AMTS Rail Monitoring with As-Built*

Recipients

To add a recipient, click on in the Recipients tab. These recipients will be notified whenever any threshold of any parameter is reached. How the user will be notified depends on the notifications preference defined as the user account was created (Email/SMS/Web). If the notifications are disabled for the user chosen to be informed, the warning icon is shown, saying that the user has disabled all notifications.

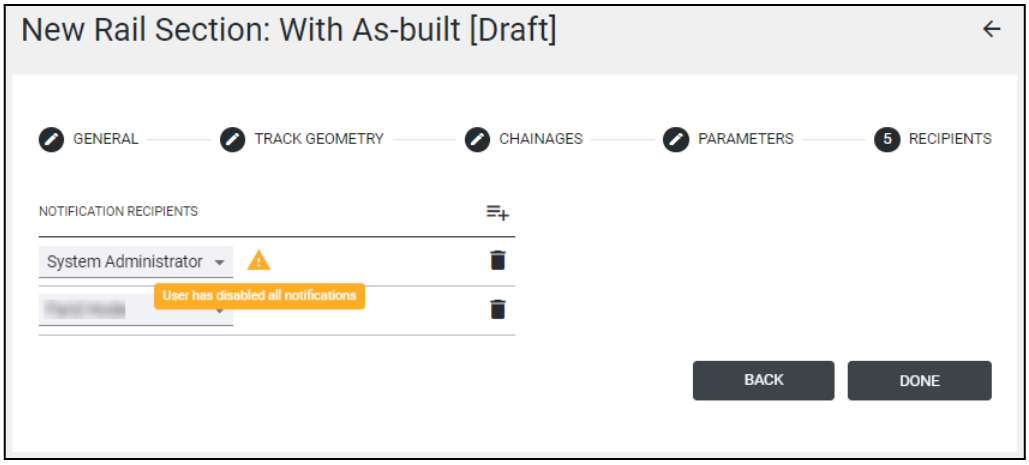

Figure 30: *Recipients Window - AMTS Rail Monitoring with As-Built*

AMTS Rail Monitoring without As-Built

General

This is where the Rail section name, sensor type, use of as-built, height reference, twist output, units for the chainage, rail geometry parameters (cant, twist, horizontal and vertical displacements, horizontal and vertical versines), and observation age have to be defined. For AMTS Rail Monitoring without as-built data, the As-Built Survey toggle must be switched off. Define the height reference, twist output, and parameter unit and decimal places. Click on the **Next** button.

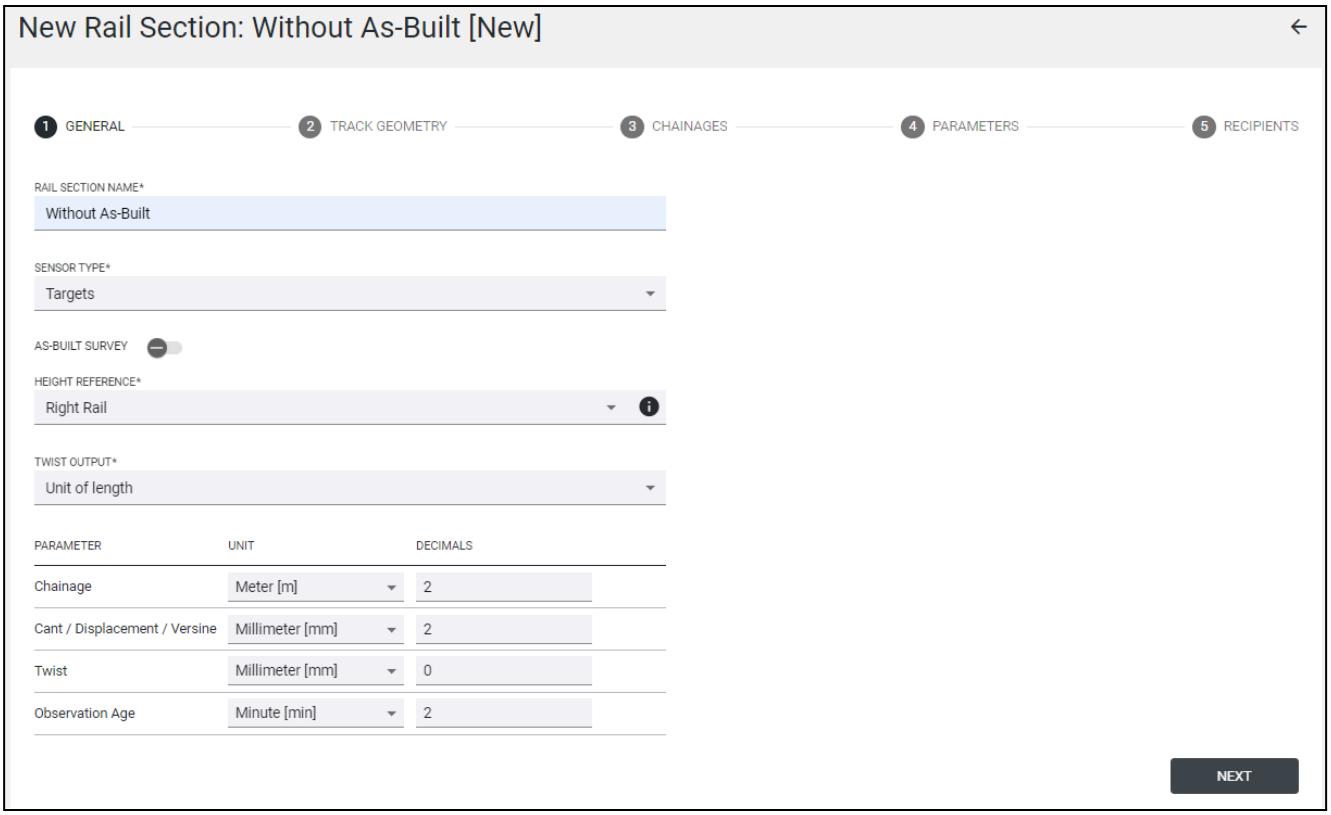

***Figure 31**: General Tab - AMTS Rail Monitoring without As-Built*

Track Geometry

Since no As-Built is being used, certain geometry data that is found in the *.track file has to be manually inputted. In the Track Geometry window, the cant basis needs to be entered, along with start chainage and chainage interval, which is the fixed distance between each prism pair along the track. Optionally, the end chainage can be specified. Finally, the left and right sensors for the first set of prism pairs must also be selected so that T4D has a starting point to sort all the other parameters across the track.

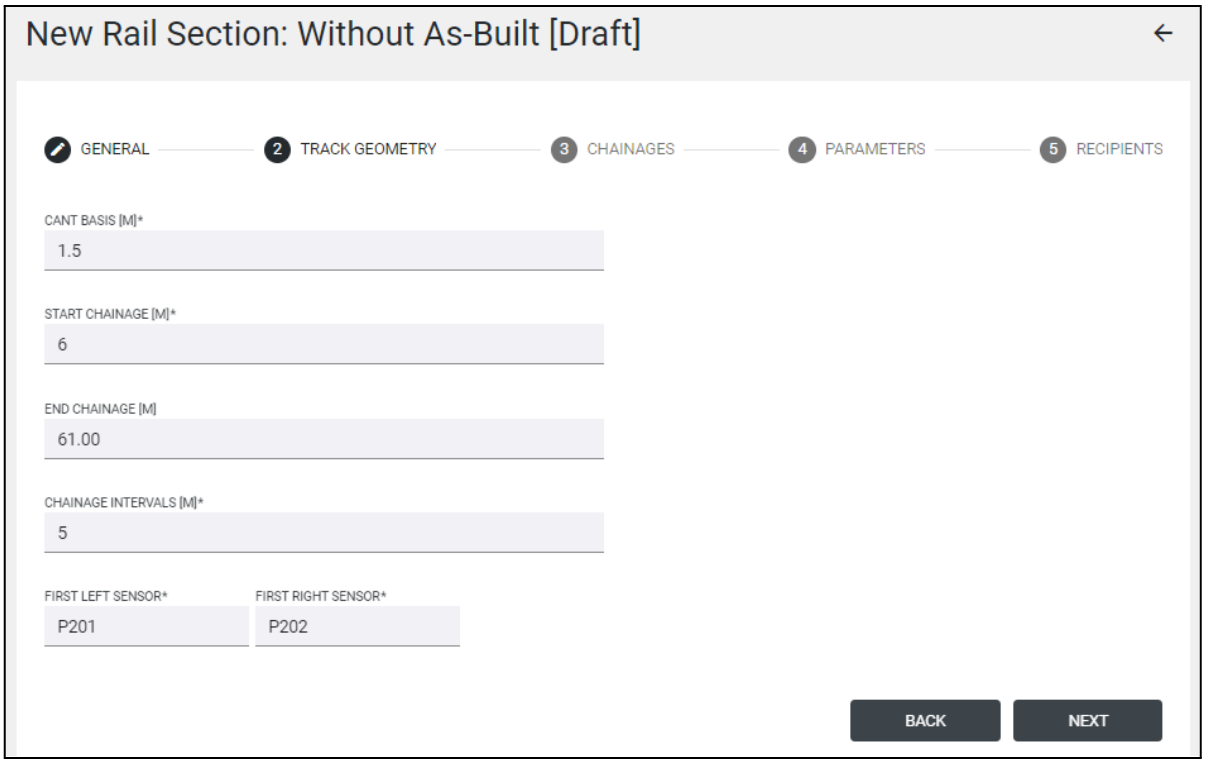

***Figure 32**: Track Geometry Window - AMTS Rail Monitoring without As-Built*

Chainages

In the **Chainages** window, the remaining prism pairs are then automatically detected with the help of the direction of the first pair defined in the **Track Geometry** window. T4D Rail will search through the sensors in the current monitoring project, which are linked to the "Coordinates" data type, are in an enabled state and optionally match the specified name prefix. Users can leverage the above to prevent a particular Target from being selected as a candidate. The chainages are also calculated and assigned accordingly. If a pair of targets is incorrectly detected, the targets can be disabled, or the prefix can be manipulated, then click on Detect. For information about chainage inconsistencies and the warning icons, refer to the Chainages subsection of the **AMTS Rail Monitoring with As-Built** section.

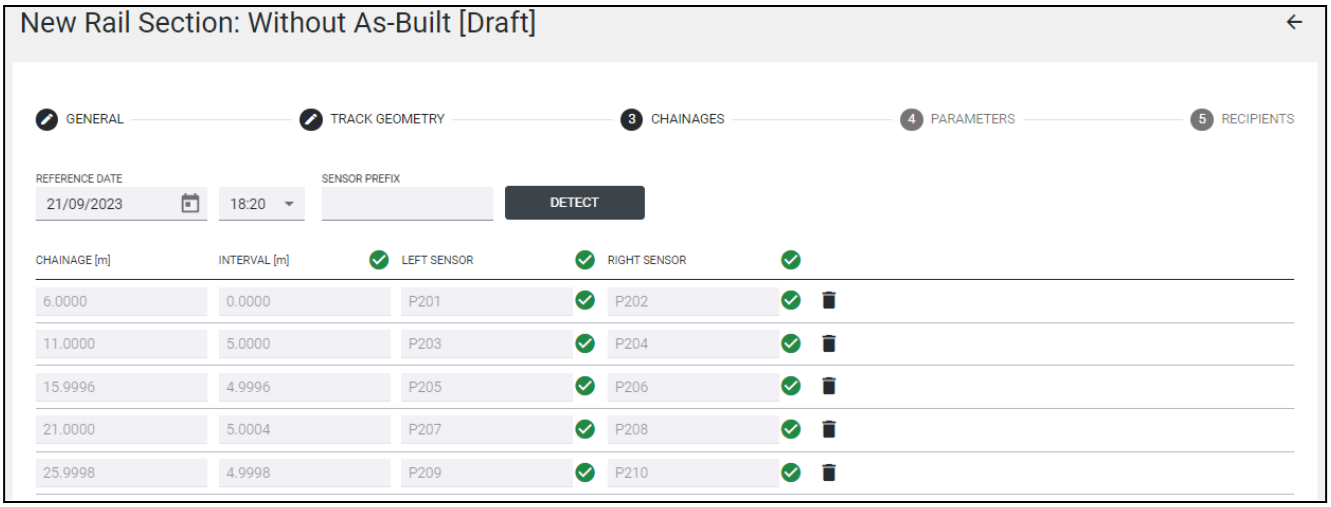

***Figure 33**: Chainages Window - AMTS Rail Monitoring without As-Built*

Parameters

The Parameters tab is where the user chooses which parameter should be monitored (monitor button). After enabling the monitor button, a threshold for attention, warning, and alarm must be entered. In the no-as-built workflow, the cant and twist values are only relative. Additionally, the parameters are calculated based on the prisms, not the track itself, as the prism to track offsets are not calculated.

If the parameter should not be monitored and alarmed on, but the user is interested in seeing how the value is changing, the parameter can only be displayed (show button).

The information button next to the parameter name gives us information about the parameter (see Figure 34).

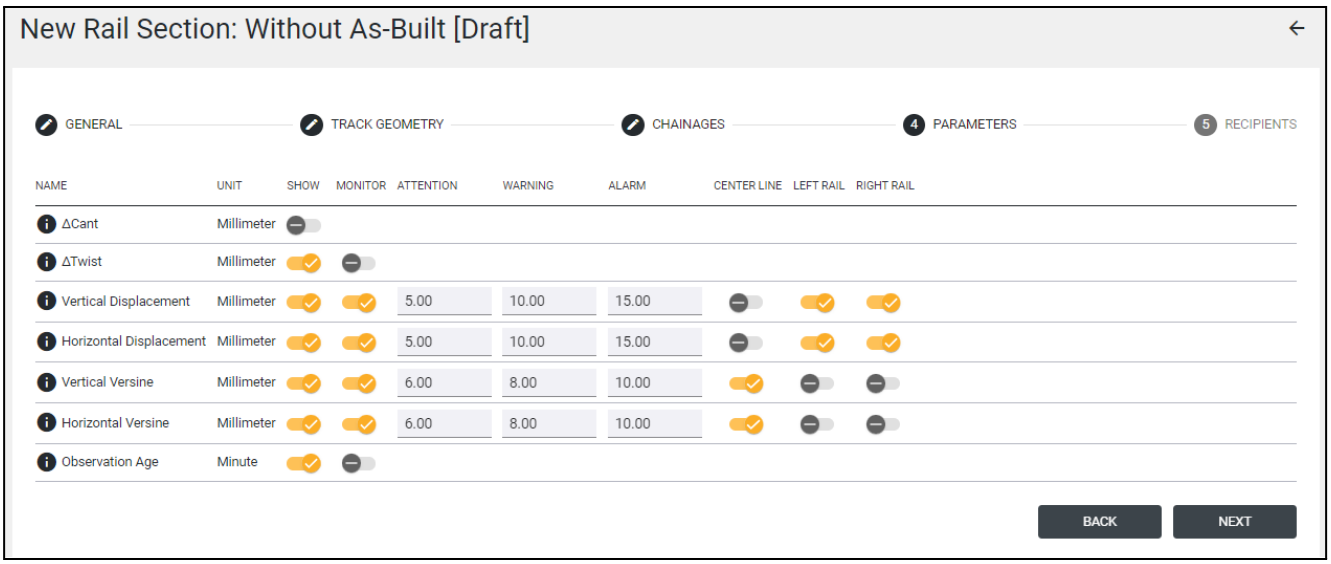

***Figure 34**: Parameters Window - AMTS Rail Monitoring without As-Built*

Recipients

To add a recipient, click on  in the Recipients tab. These recipients will be notified whenever any threshold of any parameter is reached. How the user will be notified depends on the notifications preference defined as the user account was created (Email/SMS/Web). If the notifications are disabled for the user chosen to be informed, the warning icon is shown, saying that the user has disabled all notifications.

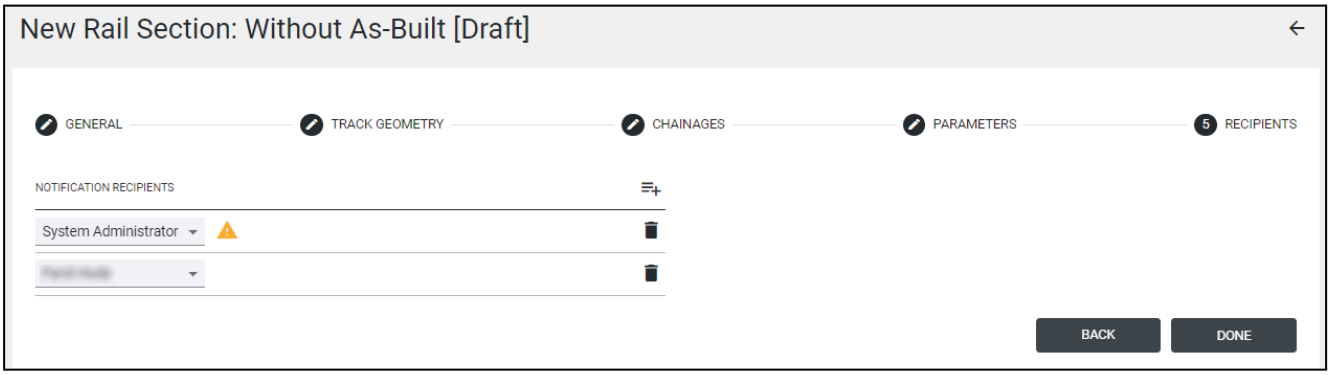

***Figure 35**: Recipients Window - AMTS Rail Monitoring without As-Built*

Rail Monitoring with Tiltmeters

General

This is where the Rail section name, sensor type, twist output, units for the chainage, rail geometry parameters (cant and twist), and observation age have to be defined. For Rail Monitoring with Tiltmeters, the sensor type must be selected as Tiltmeters. The rail section name, twist output, and parameter decimals must be defined. Click on the Next button.

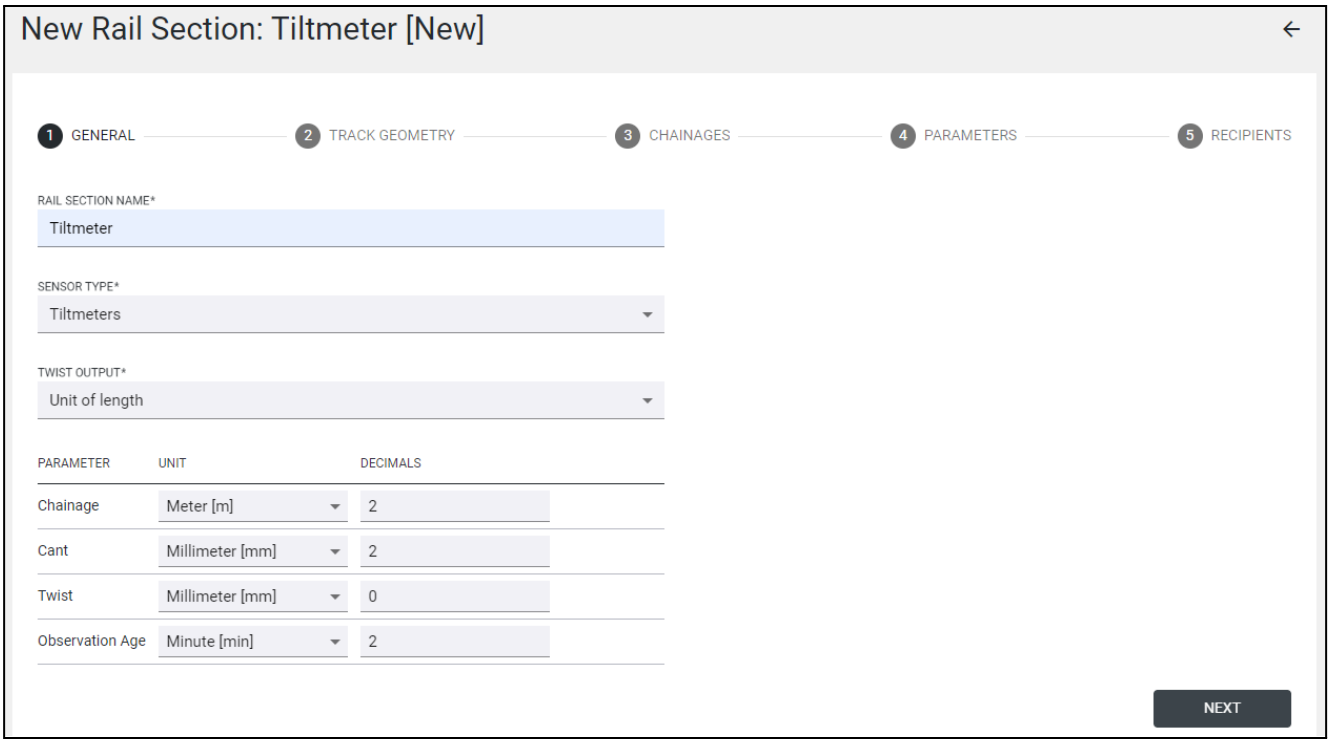

***Figure 36**: General Window - Rail Monitoring with Tiltmeters*

Track Geometry

Similar to AMTS Rail Monitoring without As-built, there is no *.track file to be loaded in the **Track Geometry** window. The cant basis must be manually set, along with the first and last sensor chainage and the chainage intervals. The first sensor (tiltmeter), the tilt component, which represents the cant plane, must also be selected from the dropdown.

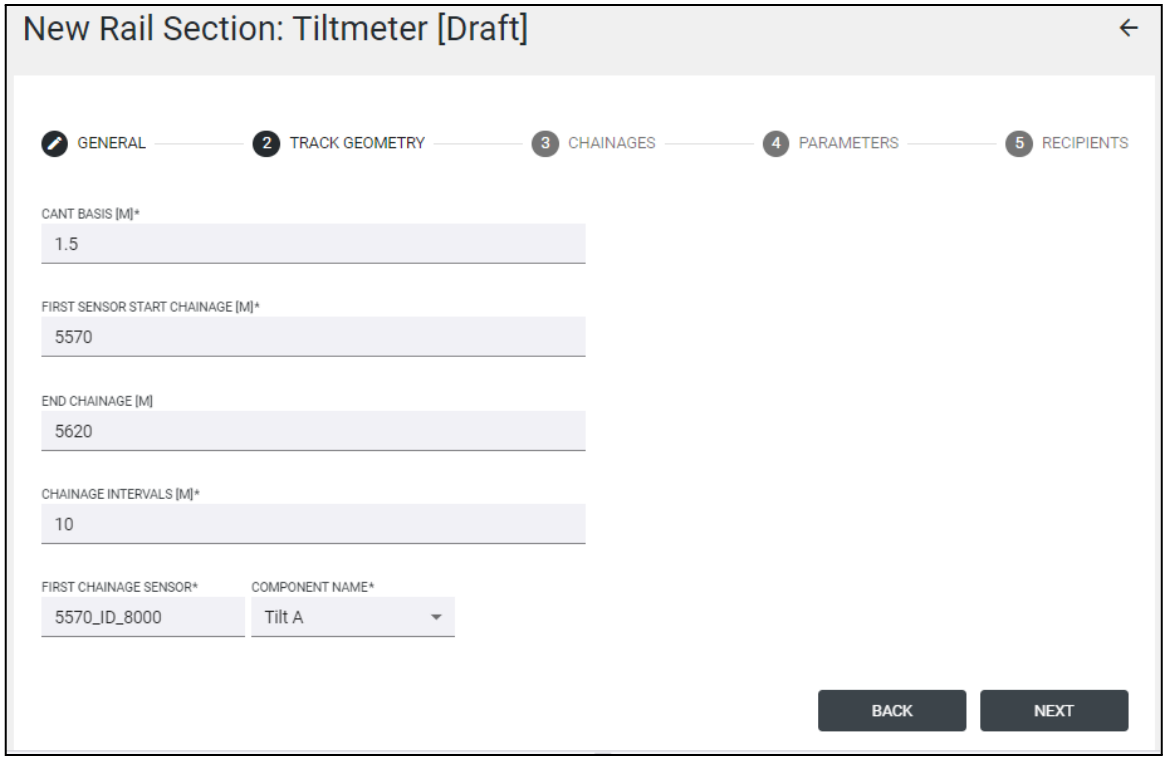

***Figure 37**: Track Geometry Window - Rail Monitoring with Tiltmeters*

Chainages

In the **Chainages** window, the remaining sensors are assigned chainages based on the chainage interval set in the **Track Geometry** window. The sensor sequence can also be set to ascending or descending depending on the project. The Detect button will automatically detect the sensor sequence from the sensor names and apply the chainage interval. For information about chainage inconsistencies and the warning icons, refer to the Chainages subsection in the **AMTS Rail Monitoring with As-Built** section.

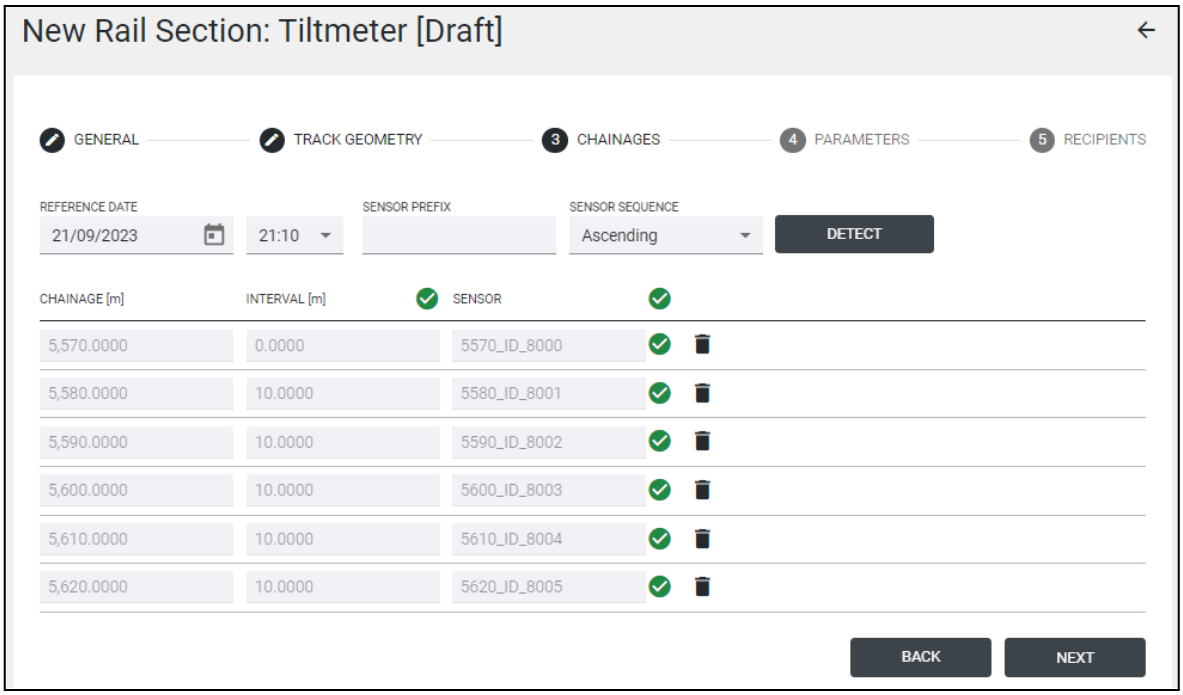

***Figure 38**: Chainages Window - Rail Monitoring with Tiltmeters*

Parameters

The Parameters tab is where the user chooses which parameter should be monitored (monitor button). After enabling the monitor button, a threshold for attention, warning, and alarm must be entered.

When tiltmeters are used for rail monitoring, only ΔCant and ΔTwist can be monitored (next to Observation Age).

If the parameter should not be monitored and alarmed on, but the user is interested in seeing how the value is changing, the parameter can only be displayed (show button).

The information button next to the parameter name gives us information about the parameter (see Figure 39).

Note:

If the thresholds are defined and changed after that, the values in the Rail section status and in the charts will only change after the next measurement round.

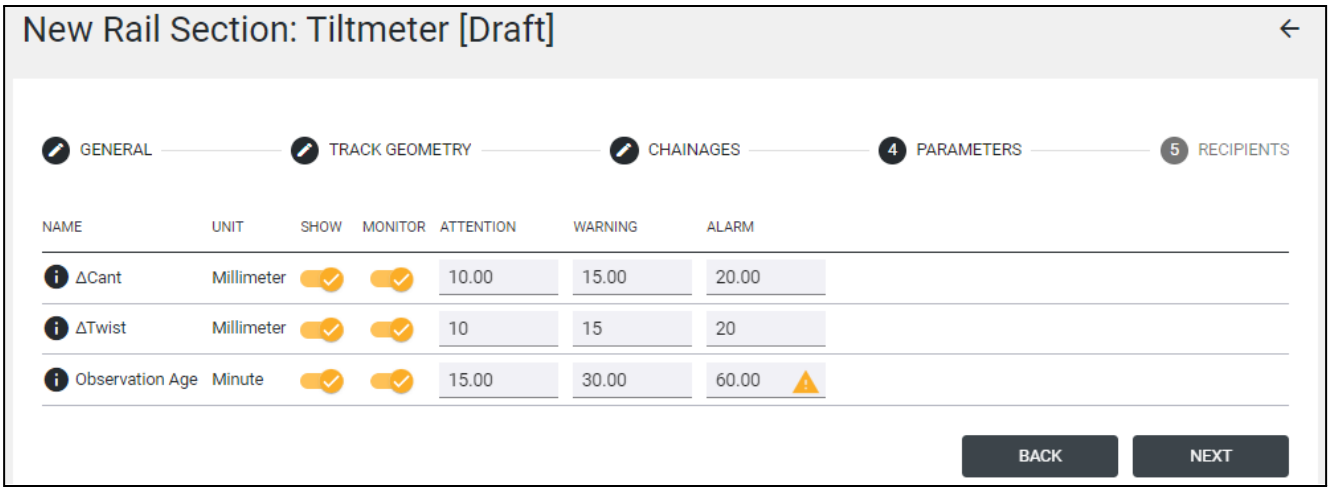

***Figure 39**: Parameters Window - Rail Monitoring with Tiltmeters*

Recipients

To add a recipient, click on  in the Recipients tab. These recipients will be notified whenever any threshold of any parameter is reached. How the user will be notified depends on the notifications preference defined as the user account was created (Email/SMS/Web). If the notifications are disabled for the user chosen to be informed, the warning icon is shown, saying that the user has disabled all notifications.

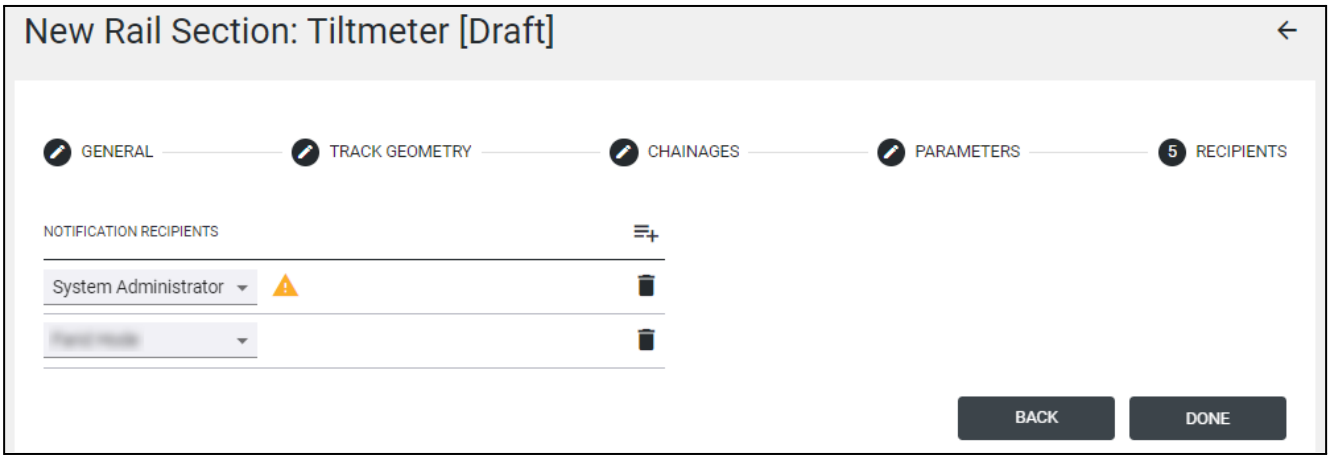

***Figure 40**: Recipients Window - Rail Monitoring with Tiltmeters*

Rail section Functionalities

Rail section Status

There are two ways to access the rail section status window. On the left-hand side, a colored button immediately gives information on the alarm condition of the rail section at the moment. There are five possible states:

- Grey empty circle – No measurement data in the Rail section
- Full grey circle – Rail section is disabled
- Green – OK
- Blue – Attention
- Yellow – Warning
- Red – Alarm

By clicking on the Status button, the rail monitoring status window opens, giving the user the overview of the last available values, colored based on the defined threshold. Only the selected parameters that are being monitored are shown.

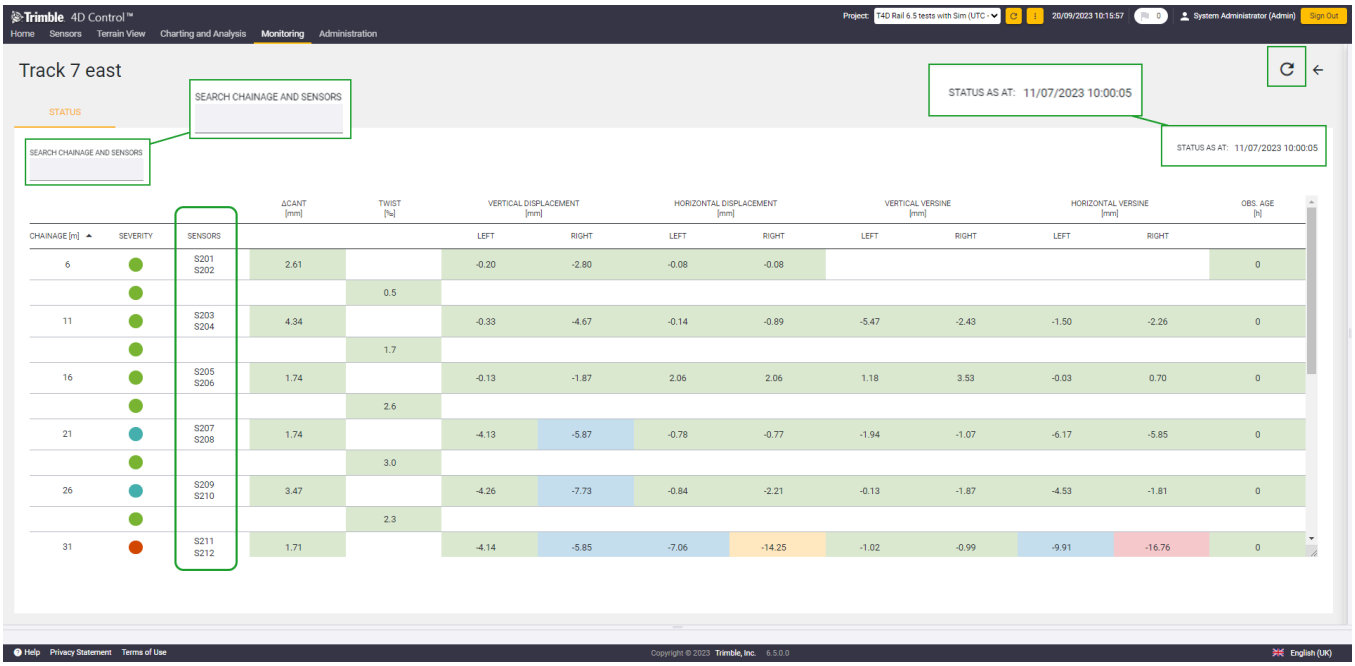

Figure 41: *Rail section Status window*

Charts by chainage

Charts by chainage help to signal which sections of the track are concerning. You can access Charts by chainage by clicking on the icon. In the component selector, it is possible to choose the parameter which should be visualized. The chainage information is shown on the x-axis. When first opening the chart, the whole chainage range is displayed. With the left mouse click, the area of interest can be selected and zoomed in. Zoom can then be reset with the Reset zoom button. The Y-axis is where the selected parameter is represented.

At the bottom of the window, there is a Date line containing all of the measured epochs. These can be pinned for analysis purposes, and up to 10 epochs can be pinned. With the left mouse click, the area of interest can be selected and zoomed in. Zoom can then be reset with the Reset zoom button. The selected epochs are shown above the Date line. These can be deselected by clicking on them.

If the parameter is being monitored, the defined thresholds are shown on the chart. These can be hidden by clicking on and deselecting the box Show thresholds.

Since T4D v6.5 charts have multi-series capabilities to plot all monitored rails, right, left, and center. This new visualization capability empowers the user to make well-informed decisions based on that visualized data.

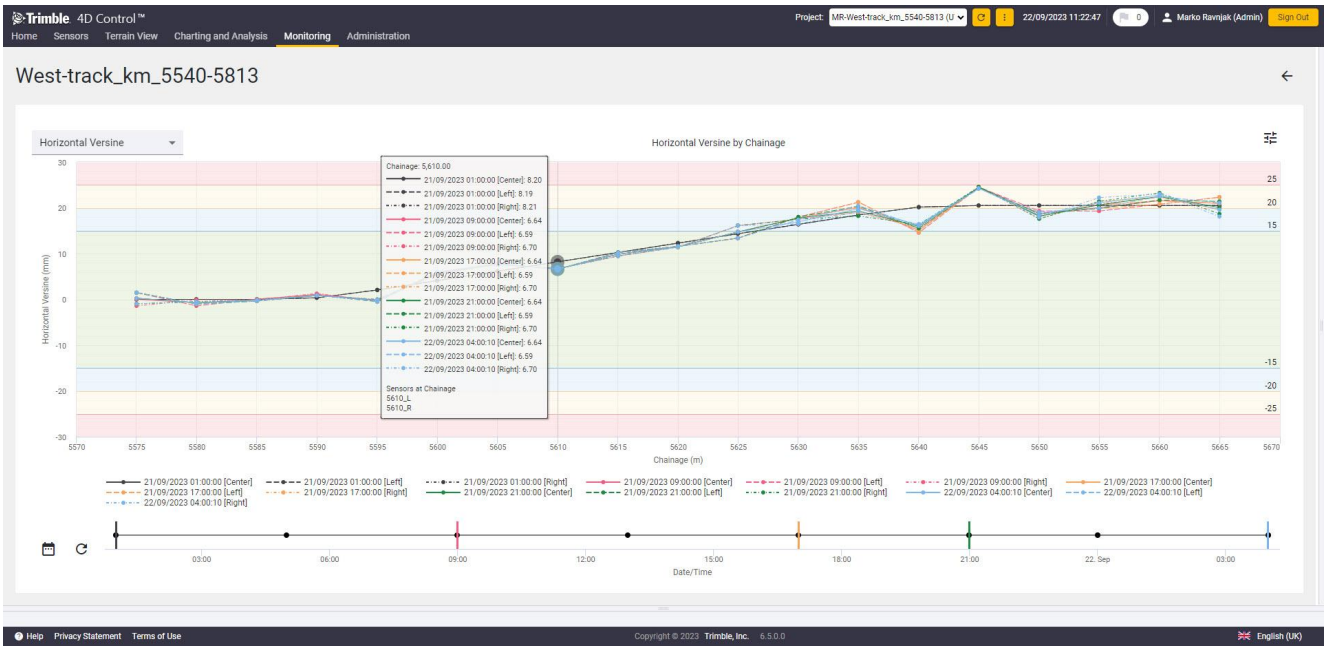

Figure 42: *Charts by chainage*

Charts over time

Charts over time help to quickly notice at which points in time unwanted movement began. You can access Charts over time by clicking on the icon. In the component selector, it is possible to choose the epoch which should be visualized. The epochs are shown on the x-axis. When first opening the chart, the last week is shown. With the left mouse click, the area of interest can be selected and zoomed in. Zoom can then be reset with the Reset zoom button. The Y-axis is where the selected parameter is represented.

On the bottom of the window, there is a Chainage line containing all of the measured chainages. These can be pinned for analysis purposes, and up to ten chainages can be pinned. With the left mouse click, the area of interest can be selected and zoomed in. Zoom can then be reset with the Reset zoom button. The selected chainages are shown above the chainage line. These can be deselected by clicking on them.

If the parameter is being monitored, the defined thresholds are shown on the chart. These can be hidden by clicking on and deselecting the box Show thresholds.

Since T4D v6.5 charts have multi-series capabilities to plot all monitored rails, right, left, and center. This new visualization capability empowers the user to make well-informed decisions based on that visualized data.

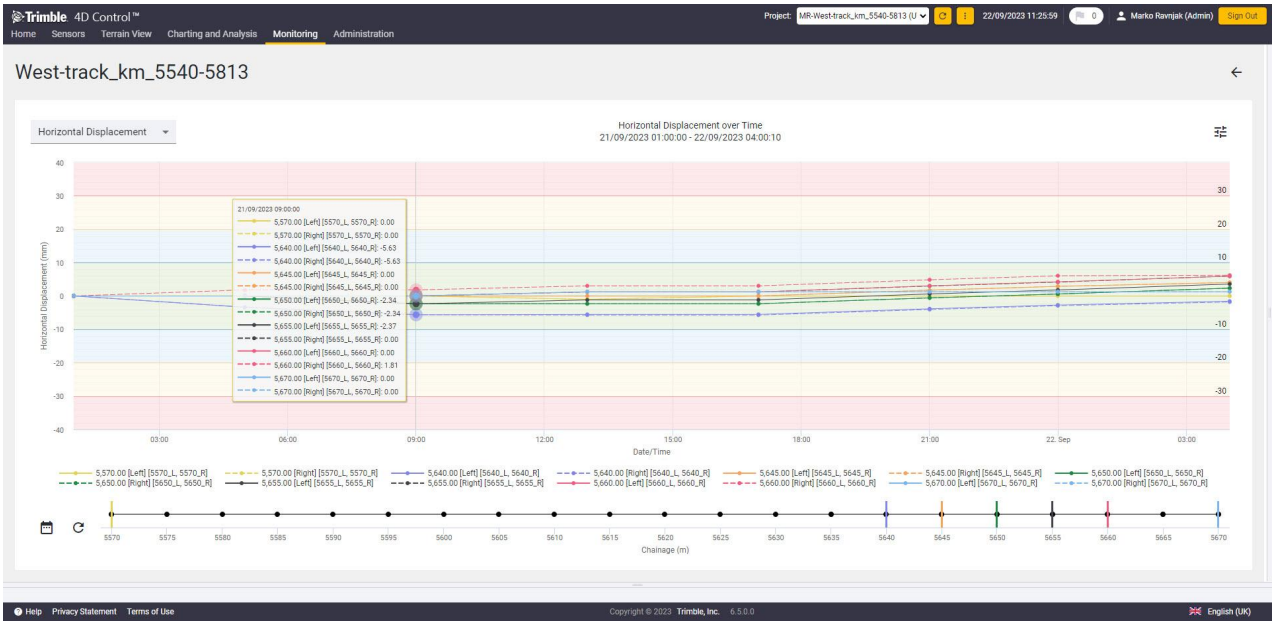

Figure 43: *Charts over time*

Export

In the Report tab, it is possible to download the XLSX file containing all of the parameters and their calculations. After selecting the Date range, the file can be downloaded by clicking on the Download Report button .

XLSX file contains information about defined thresholds, a comparison between the reference data values and current data values, and all of the values from every measured epoch of every selected parameter.

There is also an option to download a **Detailed Report**, which will also include the coordinate deltas from both the left and right rails, along with the centerline. It also provides comprehensive coordinate information, including prism coordinates and prism offsets, for both rails and the track centerline for every measured epoch at each chainage.

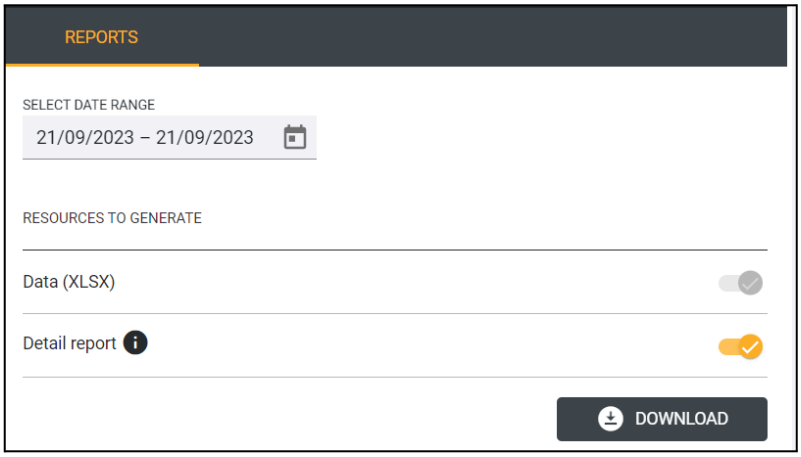

Figure 44: *Reports tab with Detailed report enabled*

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	Chainages				Reference d: 2023-07-03						Selected d 2023-07-11																
2	Chainage (m)	Monitoring Point	Number	Distance between chainages (m)	Elevation Track Center Line (m)	Twist (‰)	Vertical Versine (L) (mm)	Vertical Versine (R) (mm)	Horizontal Versine (L) (mm)	Horizontal Versine (R) (mm)	ΔNorthing Rails (m)	ΔEasting Rails (m)	ΔElevation Rails (m)	ΔNorthing Track Center Line (m)	ΔEasting Track Center Line (m)	ΔElevation Track Center Line (m)	ΔCant (mm)	Twist (‰)	Vertical Displacement (L) (mm)	Vertical Displacement (R) (mm)	Horizontal Displacement (L) (mm)	Horizontal Displacement (R) (mm)	Vertical Versine (L) (mm)	Vertical Versine (R) (mm)	Horizontal Versine (L) (mm)	Horizontal Versine (R) (mm)	Observation Age (h)
3	6.00	L	1		100.0000		-	-	-	-	0.0001	0.0000	-0.0002														
4		R	2	5.00		0.1					0.0001	0.0001	-0.0028	0.0001	0.0000	-0.0015	2.61		-0.20	-2.80	-0.08	-0.08	-	-	-	-	0
5	11.00	L	3		100.0001		-5.31	-0.09	-0.38	-0.38	0.0000	0.0002	-0.0003					0.5									
6		R	4	5.00		2.2					-0.0018	0.0030	-0.0047	-0.0009	0.0016	-0.0025	4.34		-0.33	-4.67	-0.14	-0.89	-5.47	-2.43	-1.50	-2.26	0
7	16.00	L	5		100.0055		-0.92	0.12	-2.54	-2.19	-0.0019	-0.0009	-0.0001					1.7									
8		R	6	5.00		2.6					-0.0020	-0.0010	-0.0019	-0.0019	-0.0009	-0.0010	1.74		-0.13	-1.87	2.06	2.06	1.18	3.53	-0.03	0.70	0
9	21.00	L	7		100.0118		0.00	0.00	-4.79	-5.16	0.0000	0.0010	-0.0041					2.6									
10		R	8	5.00		2.6					0.0001	0.0010	-0.0059	0.0001	0.0010	-0.0050	1.74		-4.13	-5.87	-0.78	-0.77	-1.94	-1.07	-6.17	-5.85	0
11	26.00	L	9		100.0180		0.00	0.01	-7.61	-7.10	0.0002	0.0010	-0.0043					3.0									
12		R	10	5.00		2.6					0.0021	0.0012	-0.0077	0.0011	0.0011	-0.0060	3.47		-4.26	-7.73	-0.84	-2.21	-0.13	-1.87	-4.53	-1.81	0
13	31.00	L	11		100.0243		0.00	0.00	-10.37	-10.37	0.0077	0.0024	-0.0042					2.3									
14		R	12	5.00		2.6					0.0083	0.0117	-0.0058	0.0080	0.0071	-0.0050	1.71		-4.14	-5.85	-7.06	-14.25	-1.02	-0.99	-9.91	-16.76	0
15	36.00	L	13		100.0305		0.00	0.00	-12.70	-12.57	0.0080	0.0120	-0.0019					2.3									
16		R	14	5.00		2.6					0.0070	0.0120	-0.0020	0.0075	0.0120	-0.0019	0.00		-2.00	-2.00	-14.21	-13.52	2.00	2.01	-20.91	-20.06	0
17	41.00	L	15		100.0368		-0.01	0.00	-15.12	-15.82	0.0012	0.0057	-0.0038					2.3									
18		R	16	5.00		2.6					-0.0012	-0.0019	-0.0022	0.0000	0.0019	-0.0030	-1.69		-3.85	-2.16	-4.98	2.20	-2.86	-1.15	-14.06	-7.92	0
19	46.00	L	17		100.0430		0.00	0.01	-18.55	-17.19	-0.0010	-0.0020	0.0000					3.0									
20		R	18	5.00		2.6					-0.0010	-0.0020	0.0000	-0.0010	-0.0020	0.0000	0.00		0.00	0.00	2.15	2.15	3.79	1.23	-15.04	-17.26	0
21	51.00	L	19		100.0492		-0.01	0.00	-20.62	-20.98	-0.0011	-0.0021	-0.0037					1.9									
22		R	20	5.00		2.6					-0.0010	-0.0021	-0.0002	-0.0010	-0.0021	-0.0020	-3.48		-3.75	-0.27	2.28	2.24	-3.53	3.00	-20.37	-21.15	0
23	56.00	L	21		100.0555		1.72	-0.11	-22.81	-23.08	-0.0009	-0.0018	-0.0005					4.5									
24		R	22	5.00		1.9					-0.0019	-0.0019	-0.0065	-0.0014	-0.0019	-0.0035	6.10		-0.44	-6.54	1.92	2.67	3.15	-6.52	-22.03	-21.52	0
25	61.00	L	23		100.0601		-	-	-	-	0.0000	0.0000	0.0000					0.7									
26		R	24								0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00		0.00	0.00	0.00	0.00	-	-	-	-	0

Figure 45: *Detailed Report*

Alarming

With version 6.5.2, the Rail module has been enhanced to categorize notifications, emails, and SMS messages according to priority levels. The organization follows a hierarchy, beginning with Rail Section Status, followed by an update on the specific Chainage, and concluding with a specific parameter that has changed. This refined system ensures that users are notified only about the most critical change.

One of three distinct types of notifications is possible, based on the level affected:

- Rail Section Status changed from X to Y.
- Rail Section Status remains in status X. Change at chainage () m affected Chainage Status update from X to Y.
- Rail Section Status remains in status X. At chainage () m, parameter value XY affected Parameter Status update from X to Y.

A number of recipients can be associated with each alarm definition. These recipients will be notified whenever the status of a section, chainage or parameter has changed. The users and the notifications preferences have to be defined in the Account Settings in T4D Web, and the users can then be selected in the rail module.

Note:
It is advised to configure a general alarm for all of the prisms in a project and to enable the "No Data" Alarm. For this, a meaningful "No data" time window should be defined, and a meaningful overall threshold, e.g., Δd2D and ΔdH (or Δd3D only).
Ensure that the "No Data" alarm is enabled on at least one of the conditions associated with the alarm.

Sensor replacement

For the as-built workflow, If the sensor was physically destroyed (and replaced in the field) or its position was changed, it is possible to recalculate the offsets between the prism and the top of the rail head. Additionally, if there was a change in the geometry, the track has to be surveyed again. To be able to do so, the Rail section has to be disabled. When disabled, the ***View*** button transforms into the ***Edit*** button (see Figures 46 and 47).

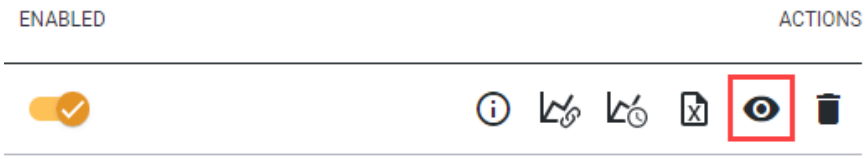

Figure 46: *Rail section information can only be viewed when enabled*

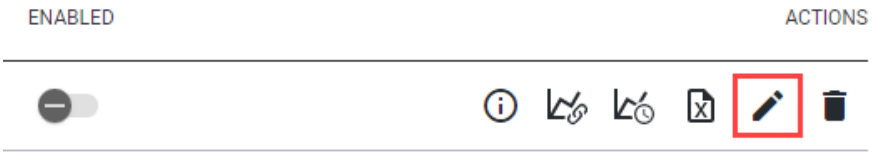

Figure 47: *Rail section information can be edited when it is disabled*

Note:

Prism replacement workflow is only advisable if the rail track geometry in the Rail section has not been deformed since the as-built survey used to configure the railway section was performed.

In this case, a new as-built survey and the creation of a new rail section are necessary.

To update the sensor, click on ***Edit*** and then select the Chainages tab in the Rail section window. Click on the ***Edit sensor*** icon . The window ***Edit / Recalculate Offsets*** pops up. The current offsets of the chosen sensor are displayed. The ***Reference date*** must be selected (1), and then it can be clicked on **Query** (2). The new reference date must be set to a date and time **after** the physical prism was replaced (or moved). The new offsets are displayed. The offsets apply from the moment when the change is applied. It is possible to apply

the offsets for the Left Sensor and the Right sensor (3), and this must be confirmed with ***Apply*** (4). After applying the offsets, the icon  is updated to show that there is an inconsistency between reference measurement dates.

Note:

When the sensor is physically replaced in the field, the first measurement of the new prism position has to be finished for the offsets to be calculated. After this is done, the new offsets can be applied to the new measurements.

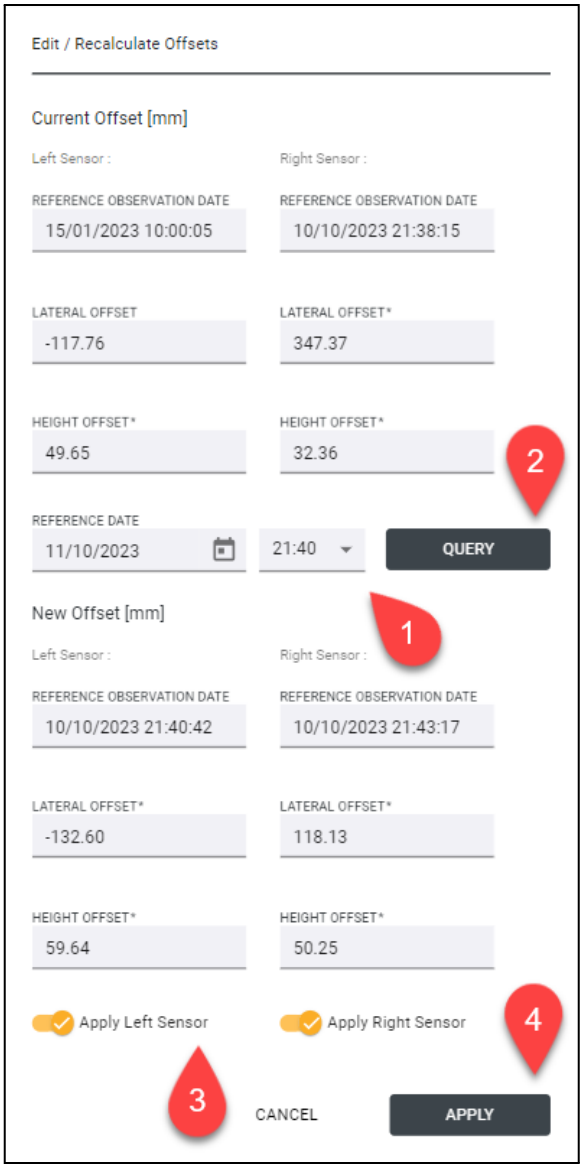

Figure 48: *Recalculating the offsets*

Delete

After the rail monitoring project is finished, the rail monitoring section can be deleted by clicking on the delete button in the rail monitoring section window.

Product versions and features

Rev. Nr.	Datum	Last changes	User
1.1	01.12.2022	First version User Guide for the Trimble 4D Control Version 6.4	MR
1.2	01.12.2023	Updated version User Guide for the Trimble 4D Control Version 6.5.2	FH

Notes